THE MODEL ENGINEER

Seasonal Greetings

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The MODEL ENGINEER

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SMOKE RINGS

Our Christmas Offering

● WITH OUR cordial good wishes to all readers, we offer this issue of THE MODEL ENGINEER. As was the case last year, some of the contents are frankly light-hearted in character, as befits the Christmas Season. Although our hobby is a serious one and most of us take it seriously, yet there is hardly any need for us to remind readers that it offers many opportunities for breaking through that mask of seriousness.

So we hope that every reader will find in this issue something to enjoy in more ways than one. Even the advertisements seem to convey a message, if only because their number indicates clearly that the trade is very much alive. The reading of advertisements is always an interesting and frequently a profitable pastime. Perhaps those in the front and back pages may be more so than usual.

Soon we shall be beginning another year, and we are looking forward to it with the usual pleasure and confidence; but, for the next few days, we can all pause to gather a little strength. Good modelling to you all!

Models of Fire Appliances Wanted

● AT THE recent Building Exhibition at Olympia, our special attention was directed to the stand of the Fire Protection Association, where we were privileged to inspect a very beautiful model of one of the old type of ladder escape units. The model, which was to the scale of about 1 in. to the foot, was accurate to the very smallest detail and painted in the long-established "Post Office" red with black lining. It was a typical example of the then familiar "Merryweather" production.

We understand that the Fire Protection Association plans to make a collection of models of fire-fighting and fire-protection appliances of all kinds; but they *must* be absolutely authentic and correct to scale, though not necessarily all to the same scale. If any reader knows of the existence of such models for disposal, he is invited to get into touch with Mr. W. H. Tuckey, Director, the Fire Protection Association, 84, Queen Street, London, E.C.4.

Chichester Exhibition, 1950

● THE CHICHESTER and District Model Engineering Society will be holding its annual exhibition at the Assembly Room and Council Chamber, Chichester, during the week beginning February 20th, 1950. Since the exhibition will be drawn from the work of model engineers over a wider area than before, an even higher standard of workmanship than last year is expected. Messrs. W. G. Pope and J. Prevett are the organisers of the show, and they are hoping that the 1949 total of 5,000 visitors will be exceeded.

B.R. "King" Class Locomotives as Prototypes

● SOME RECENT comments of ours, regarding models of British Railways Western Region "King" class engines seem to have raised a mild controversy; therefore, we feel justified in pursuing the matter a little further. Our original comment was to the effect that most miniature reproductions of "Kings" fail to suggest that impression of majestic massiveness which is such a prominent characteristic of the prototype. Some of the miniatures which we have seen suggest an engine that is somewhere about halfway between a "Castle" and a "King"; others have possessed certain features which, through being over-emphasised, have produced a bloated effect that ruins the appearance. Our ideas seem to be supported by the fact that, occasionally, and in various localities by no means always in Western Region territory, we have come across a model which is a perfect little portrait in metal, structurally and artistically. That shows it *can* be done.

The "King" is not an easy engine to reproduce in a small scale, and the problem is made more difficult in that we have yet to see any really accurate drawings; even the official diagram is not correct, and this is probably the chief cause of the faults so often seen in the models!

The few accurate models we have seen have been based, we believe, on the official diagram, but supplemented by numerous dimensions taken from actual engines. The usual official diagrams can be relied upon for the main basic dimensions such as the division of the wheelbase, boiler centre height and the like; but these diagrams are often too sketchy to be of any use for settling details like the outside diameter of the smokebox, the correct shape of the windows in the cab-sides, the proper size and shape of the chimney, and so on. It is such details as these which, unless they are correct, can spoil the appearance of a model so easily.

Good photographs, carefully studied, can do much to help the modelmaker out of difficulties like these, and should always be available during the construction of the model, so that any doubtful points can be investigated and corrected while the work proceeds. Time spent in studying photographs is always time well spent in the interests of accuracy; for only in that way can a true estimate be made of the characteristic features of any prototype.

Compliments from New Zealand

● MR. T. M. ELLIS, writing from Otago, New Zealand, takes the opportunity, *inter alia*, to pay some compliments to THE MODEL ENGINEER and what he refers to as "the splendid articles therein." He writes: "The items by 'Duplex' are particularly interesting, and one feels that anything from them is sound. I am interested in accounts of models of all kinds and the making of them—both success and failure—as one often learns as much from the latter as from the former.

"While I cannot by any means claim to be the oldest subscriber, my introduction to THE MODEL ENGINEER dates from 1904, and I have a fairly complete collection of bound volumes from that date. I bind my own copies, taking my cue from an article which you published in 1907, and upon which my binding practice is based."

We feel that we need scarcely remark that comments like these are most gratifying to our contributors, our staff and ourselves; and we are wondering how many other readers bind their own copies, taking that 1907 article as their guide.

Although Mr. Ellis is just about as far from us as he can be in this world, there can be no doubt that the personal link is strongly evident; and that is as we would wish it.

Railwaymen on their Mettle!

● TWELVE MONTHS ago, British Railways, London Midland Region, instituted a drive to recover old nuts and bolts, steel rails and other metal scrap. We have just received official information to the effect that the drive has produced the astonishing total of 115,532 tons of scrap metal!

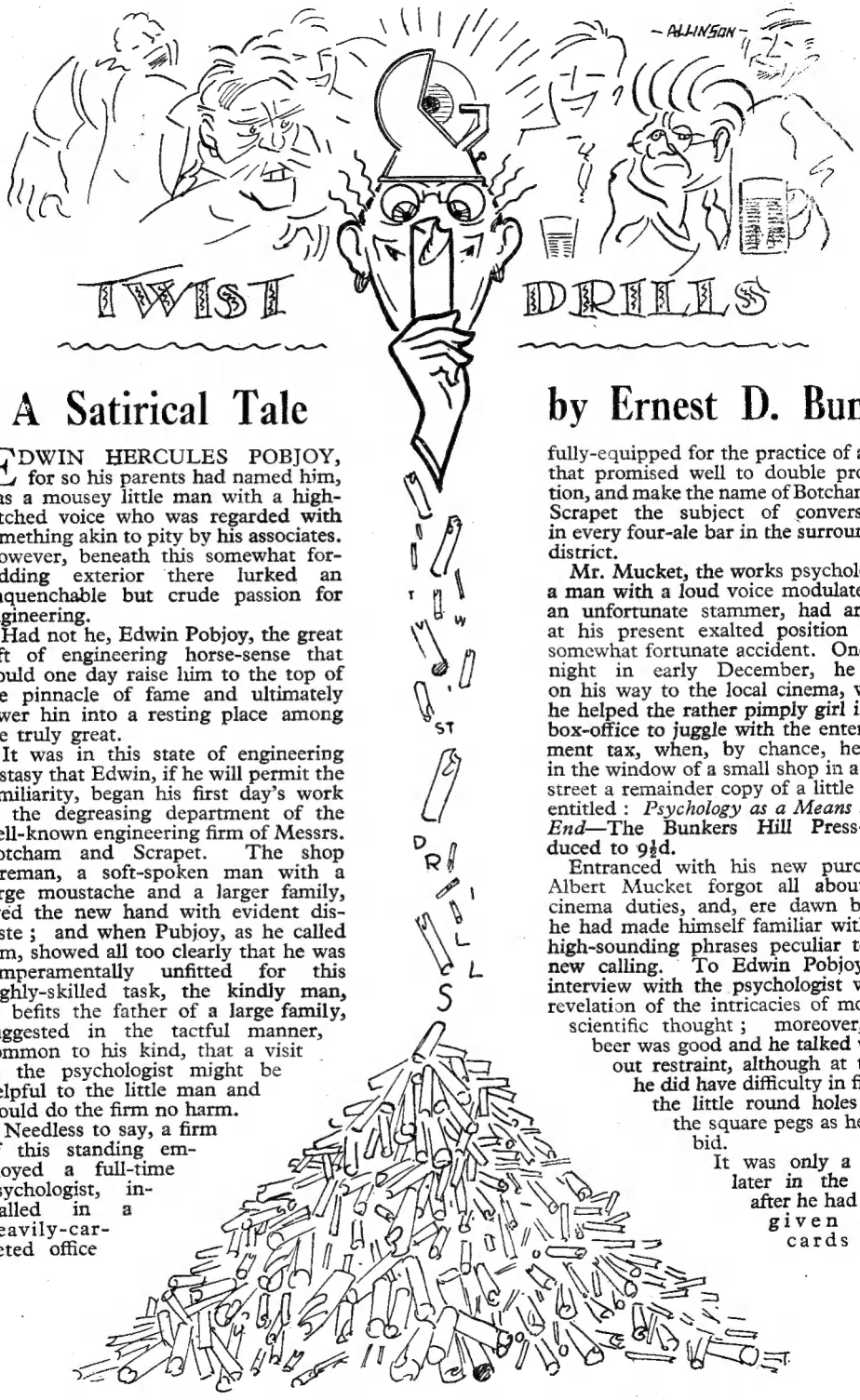
We imagine that by far the greatest individual item in the total is made up of old steel rails, not many miles of which would easily make up to the whole amount. Cast-iron chairs, with their fixing-nuts and bolts, probably reached a substantial amount. This being so, the total figure serves to focus our attention upon the vast quantity of metal that is used by the railways, and we sometimes have wondered if any statistically-minded individual has ever attempted to assess, even to the nearest million tons, the total quantity of metal involved in railway construction. It must amount to a truly astronomical aggregate.

The Second Northern Models Exhibition

● SINCE WE published, in our issue for November 10th last, the preliminary announcement of the second exhibition to be organised by the Northern Association of Model Engineers, some further details have come to hand. For the benefit of strangers to Manchester, we would say that the Corn and Produce Exchange, where the exhibition will be held, is next to Manchester Cathedral.

One of the outstanding exhibits will be a scale model of a fairground of the 1903-1913 period, complete with all the details of the attractions including such side-shows as the helter-skelter, the fat lady, the moving pictures with orchestration on the front platform, living caravans, traction engine, and of course, the roundabouts. This exhibit is the work of Mr. M. C. B. Arthur, of Bolton, a technical engineer and a native of County Durham, who has spent ten years in research and work to complete it.

Another period-piece will be a model of Barlow Hall in South Manchester, made by Mr. E. L. Blane, a newspaper artist of Baguley and a member of Chorlton Golf Club which has this building as its club-house. He has spent many hours around the structure, collecting details to transfer to his miniature in wood, card and paper.



A Satirical Tale

by Ernest D. Bunke

EDWIN HERCULES POBJOY, for so his parents had named him, was a mousey little man with a high-pitched voice who was regarded with something akin to pity by his associates. However, beneath this somewhat forbidding exterior there lurked an unquenchable but crude passion for engineering.

Had not he, Edwin Pobjoy, the great gift of engineering horse-sense that would one day raise him to the top of the pinnacle of fame and ultimately lower hin into a resting place among the truly great.

It was in this state of engineering ecstasy that Edwin, if he will permit the familiarity, began his first day's work in the degreasing department of the well-known engineering firm of Messrs. Botcham and Scrapet. The shop foreman, a soft-spoken man with a large moustache and a larger family, eyed the new hand with evident distaste ; and when Pubjoy, as he called him, showed all too clearly that he was temperamentally unfitted for this highly-skilled task, the kindly man, as befits the father of a large family, suggested in the tactful manner, common to his kind, that a visit to the psychologist might be helpful to the little man and would do the firm no harm.

Needless to say, a firm of this standing employed a full-time psychologist, installed in a heavily-carpeted office fully-equipped for the practice of a cult that promised well to double production, and make the name of Botcham and Scrapet the subject of conversation in every four-ale bar in the surrounding district.

Mr. Mucket, the works psychologist, a man with a loud voice modulated by an unfortunate stammer, had arrived at his present exalted position by a somewhat fortunate accident. One wet night in early December, he was on his way to the local cinema, where he helped the rather pimply girl in the box-office to juggle with the entertainment tax, when, by chance, he saw in the window of a small shop in a back street a remainder copy of a little book entitled : *Psychology as a Means to an End*—The Bunkers Hill Press—reduced to 9½d.

Entranced with his new purchase, Albert Mucket forgot all about his cinema duties, and, ere dawn broke, he had made himself familiar with the high-sounding phrases peculiar to his new calling. To Edwin Pobjoy the interview with the psychologist was a revelation of the intricacies of modern scientific thought ; moreover, the beer was good and he talked without restraint, although at times he did have difficulty in fitting the little round holes into the square pegs as he was bid.

It was only a little later in the day, after he had been given his cards on

dismissal, that he learned that his intelligence quotient has been assessed at 0.01 per cent., and his engineering aptitude as nil—minus.

To a man of Pobjoy's make-up this information and his abrupt dismissal meant little, and he decided to take up engineering intensively on his own account.

" the coalman shot in half a ton of kitchen cobbles "

First of all, he decided, he would construct a scale model of the Mwschski dam built by the Zero-Sluts on the upper reaches of the River Bugge ; for would not this powerful and opulent country, financed largely by our own generous government, be only too ready to buy his model for their forthcoming Super-National Exhibition later in the coming year ?

Pobjoy had told me of his model when we chanced to meet in the street one wet night in mid-December. The next day I went round to see him in his coal-house workshop, and the first thing that struck me was that everywhere, on the floor and on the shelves, were piles of what I took to be the shanks of twist drills from which the fluted portion had been removed.

In answer to my question, he explained that, before he could make certain parts with which to start on the foundations of the model, he required one, or perhaps two, properly sharpened twist drills, and that the scrap material I saw lying about was merely the result of unsuccessful grinding attempts.

He said, moreover, that he had succeeded in attaining a high degree of skill in using his left hand when supporting the drill, but until he could achieve the correct hypo-thalamic motion—the Greeks had a name for it—with the right hand no drill could be properly ground. He went on to explain that, when he had mastered this elaborate technique, even the skilled hand-workers employed by Messrs. Moose in their Oklahoma twist drill factory would look like a lot of purblind botchers.

When next I met Pobjoy one foggy night towards the end of December, he seemed delighted with the progress he had made, for as he told me, with some show of elation, he had ground one twist drill lip correctly, but unfortunately he had ground too much of the second lip so that he had to re-grind the first.

I could not help noticing that a tone of sadness then crept into his voice when he went on to tell me that he had had in this way to grind first one lip and then the other, until at length he had reached the ends of the flutes ; his engineering horse-sense then told him that however accurately he ground the remaining portion it would never make a serviceable drill.

He was, he continued, just starting on another drill when the coalman shot in half a ton of kitchen cobbles and that finished his work for the time being, besides burying the grinding machine.

As I could not help feeling a little sorry for Pobjoy, I asked him round for a friendly cup of tea and an engineering chat.

To create a good impression on the connoisseur, who was looking wistfully at my fine display of partly-finished models on my capacious shelves, I started up the grinding machine, put the drill in the grinding jig and sharpened one of its edges.

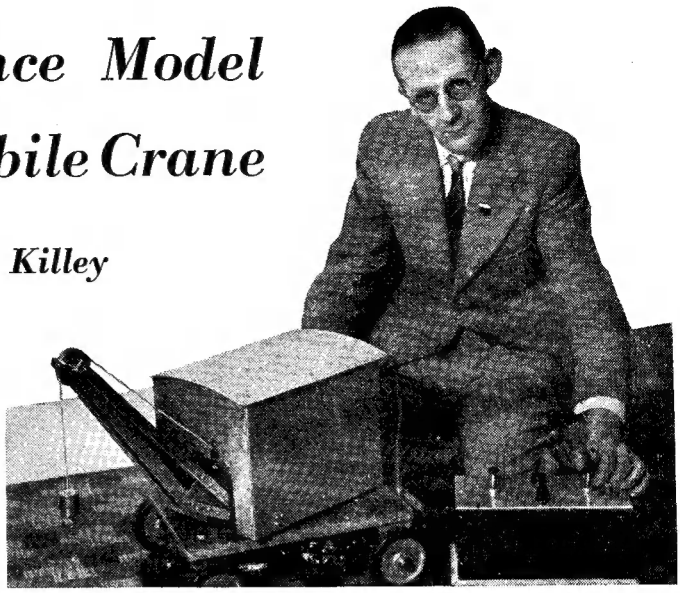
Before I had time to finish the second edge, Pobjoy, hearing the all too familiar sound of the grinding machine, hurried over to see what I was doing. He seemed amazed and almost stupified, and as he turned away I could not help noticing that he had his handkerchief in his hand and that he brushed it slowly across his eyes. When he had regained control of himself, his words came thickly : " Tell me," he said, are such jigs to be bought ; if so I will write this night to Stagg & Bryan, they may know of them."

It was only after he had left that I realised that what I had taken for misguided obstinacy was in reality crass ignorance.

The little book I sent him as a belated Christmas gift will, I hope, help him to make his exhibition model if not his fortune.

*A Free-lance Model Electric Mobile Crane

by E. J. Killey



The model crane with gib partly lowered and slewed to left, and control panel

AFTER looking over a mixed collection of oddments and motors removed from ex-W.D. radio and electrical equipment which had gradually accumulated, plus a request from junior, aged 5, for a crane "that worked itself," I decided that it would be a promising model to make.

The first decision was that it must be robust to stand plenty of rough handling, and also to allow it to lift over a semicircle, possibly on and uneven floor, without distorting out of shape and thereby putting the gearing, etc., out of line. Then as various motors proved fairly powerful, safety devices had to be incorporated to prevent either jamming of movements through doing the wrong thing at the wrong time, or more likely, damaged fingers!

The next problem was size! A lot had to be crammed into a small space, and it had to have some resemblance to "scale." Above all it had to be kept somewhere indoors. After this came the "big push" and a start was made on the bogey or mainframe. This was made 14 in. long by 10 in. wide of $\frac{1}{8}$-in. steel plate, reinforced with $\frac{1}{2}$-in. × $\frac{1}{2}$-in. × $\frac{1}{8}$-in. steel angle riveted along the four sides to make for neatness. The four corners of the angle were mitred, and welding the joints resulted in a solid frame being formed before riveting on to the plate. Next, two brackets were cut from $\frac{1}{8}$-in. plate, drilled out $\frac{5}{8}$ in. and fitted with bronze bushes to take a $\frac{7}{16}$ in. diameter rear axle. These were then riveted on to the inside of the angle to bring the centre of the bushes $1\frac{1}{4}$ in. from the back edge and $2\frac{3}{4}$ in. from the top of the plate. Two steadying brackets were then made from $1\frac{1}{2}$-in. × 16-gauge steel and bolted from just below the bushes to the centre of the top plate.

The front axle came next, and follows standard motor car practice, the axle beam being two pieces of 1-in × $\frac{1}{4}$-in. mild-steel, spaced $1\frac{5}{16}$ in. apart, spacers of $\frac{3}{4}$-in mild-steel faced off each end and drilled $\frac{5}{16}$ in. being used for these to ensure all would line up when assembled. The beams were cut 10 in. long overall and ends radiused, then clamped together and drilled $\frac{1}{2}$ in. at 9-in. centres for swivel pins, and also drilled $\frac{5}{16}$ in. at $7\frac{1}{4}$-in centres for fixing bolts. Bronze bushes were made for the $\frac{1}{2}$-in. holes and reamed $\frac{5}{16}$ in. To make construction easier, swivel pins and stub axles were made in one piece (copied from Foden steam wagon practice).

They started off as two pieces, $\frac{5}{8}$ in. diameter mild-steel rod, each 2 in. long., one end being turned down to $\frac{5}{16}$ in. for $\frac{3}{8}$ in., and the other $\frac{5}{16}$ in. for $\frac{5}{8}$ in. leaving 1 in. plain in the centre, which was drilled and tapped $\frac{5}{16}$-in. B.S.F. and counterbored for approximately $\frac{1}{8}$ in. The stub axles themselves were $\frac{1}{2}$ in. diameter mild-steel, $2\frac{1}{2}$ in. overall, turned down for $\frac{5}{8}$ in. from one end and threaded $\frac{5}{16}$-in. B.S.F. A $\frac{1}{4}$ in. wide collar was left for the wheel to butt against and the remainder turned down to $\frac{5}{16}$ in. diameter. After screwing together they were pinned with $\frac{1}{16}$-in. pins and filed up clean; then drilled at right-angles to the stub $\frac{3}{16}$ in. from the top of the plain portion that has the longest spindle projecting, with a $\frac{3}{16}$-in. drill. These are the top ends of the stubs when assembled. The axle was then assembled as follows: lower beam king-pins short end down, a ball thrust race $\frac{5}{16}$-in. bore on each pin at the top, and then the top beam spacers slipped in and two bolts put through and tightened up. If all is in line, this will give free movement of the swivel pins. Two steering arms made of $\frac{1}{4}$-in. rod were turned down $\frac{3}{16}$, and threaded for retaining nuts, and flattened at the other end. These were next fitted, the L.H. one from the driver's position being drilled 1 in. from the shoulder for a clevis pin, whilst the R.H. one was drilled at 1 in. again, and also at $1\frac{1}{2}$ in. to take the drag link. The track-rod

**The 1st prize-winning article in the "M.E." War Surplus Competition.*

is simply a piece of ⅜-in. copper tube with one half of an aircraft wire strainer sweated in each end, as these are supplied threaded left and right hand. Two are used, as the two yokes serve to couple to the steering arms, using the clevis pins supplied, and they cost only 3d. each, being surplus from world war No. 1.

Adjustment of this alters the track so all is easy going. Two packing pieces or collars cut from 1-in. conduit serve as spacers between the axle and plate to bring the axle centres level with the rear. Two holes drilled 7¼-in. centres in the plate, serve to join the two together using long bolts through the plate and packing axle beams and spacer.

I should here mention that the wheels used were 4-in. o.d. die cast with $\frac{5}{16}$-in. bore bosses, rubber tyred, approximately 1 in. wide on tread. Next came the main pin on which the cab revolves. A 12 V ex.-A.M. motor, Ref. No. 14A/988, used for flexible drive provided a useful casting for the basis of this. The outrigger bearing was taken off the motor, and a brass flange was made the same o.d., and spigotted to fit into the casting. The spigot was made ¼ in. long to enable the ⅛-in. plate to be sandwiched in between this brass flange, being bored out for ½ in. to take a ball thrust journal bearing so that it allows the cab to revolve freely and takes the whole thrust load as well. The only bearing on hand was unfortunately metric size, a few thou. over ⅝ in., so a piece of $\frac{11}{16}$-in. mild-steel was turned down to fit the bore of the race, allowing 1 in. to project through, which was further reduced in size to take the swivel gear whilst the other end was turned down to fit the brass bush in the casting. A plain washer and split-pin, at the bottom, later on saved the lot pulling out. The whole lot was assembled and held in the middle of the deck by four 2-B.A. steel screws. Next came what proved to be one of the worst jobs of all, namely, the swivelling gear and motor. First the gear was tackled. This was a brass double helical gear and pinion, taken from a pedal-driven generator set, ex-W.D. of course. It was approximately 3¼ in. diameter built up of two sections, the teeth riveted on to the hub. The rivets were drilled out carefully one at a time to keep the lot in alignment, and drilled 2 B.A. clearance half way through. The remainder drilled and tapped 2 B.A., was then bolted up with 1-in socket-head screws inserted from the boss side, leaving six studs projecting approximately ⅝ in. to bolt the upper deck on to later on. The 1 in. portion of the main pin was turned down to fit the bore of the gear, and then a thin shim washer was dropped over to serve as dust-excluder for the ball-race which was previously packed with grease and the gear pressed home. A motor which proved to be a Lucas S.W.4 wiper motor seemed most suitable for this task and as the drive shaft in it is well geared down, and is a shaft with two flats on it, it only meant slotting the pinion shaft to drop over it. The motor was then bolted up from the underside of the plate, laying parallel with the axle, the pinion and projecting part of the wiper gearbox coming through a ¾-in. hole in the plate in the 10.30 o'clock position, from driver's position again. Suitable packing was superimposed to allow for meshing up the gears. A steady bearing was bent up out of $\frac{3}{16}$-in. brass and fixed to the top to steady the pinion.

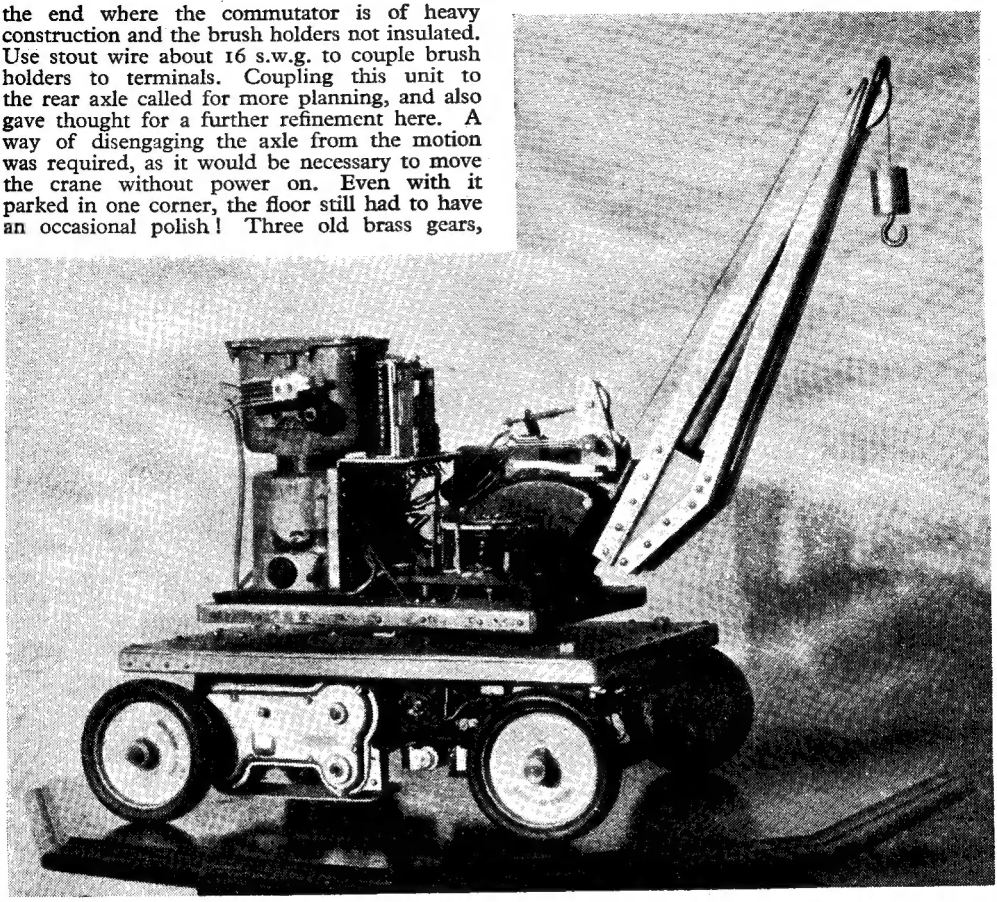
As all the motors had to be made reversible, the alterations are best described for each motor, so let us consider each one individually. The slewing motor is a Lucas S.W.4, and the alteration to this one is very simple, being shunt wound. On removing the end cover, two wires are seen soldered to the brush holders, and the two-field wires are found soldered into these from the back. So removing the endplate extend the field wires out through two holes and bring them to two separate terminals on the end cover. Solder back the two main wires to brush holders and connect to original terminals. If all is O.K. you now have the armature connected to the original terminals via the brushes and field coil to two new terminals with *no* interconnections. As a check up, join one main and one field together and other main and field put 12 V d.c. across it. The battery off the laid-up car is useful here. Note the direction of rotation, then change the field connections over and check rotation when it should be found to be reversed.

A small motor approximately 2½ in. long × 1½ in. × 1½ in. with double worm reduction gearbox fitted serves to operate the steering. These motors have been referred to in adverts in THE MODEL ENGINEER in 24 V range, less gearbox as E524. The main terminals of these consists of two blobs of solder only. So remove gearbox and armature, carefully sort out and extend the field wires again, drill two small holes in the carcass (it is die-cast alloy) to lead the wires out. Mount a small terminal block on the side and attach these wires and also solder two wires from the existing blobs of solder and extend to two more terminals. All is ready for checking over and free running again. A steering arm was made to fit on the spindle of the gearbox and gripped by a clamp screw, being drilled the other end 1½ in. from centre of the spindle hole for clevis pin. The motor was then positioned so that with the steering arm on the motor pointing forward and the wheels straight, the two holes in the arms are in line. Four 4-B.A. countersunk screws through the plate and into the holes already tapped into the motor carcass completed the fixing. A piece of $\frac{5}{16}$-in. mild-steel rod with yokes screwed on each end forms the pull push rod or drag link, which should then lay approx. parallel with the track rod.

For the traction unit a 12 V motor generator, Ref. No. 10A/12006B, 11-12 V input is used complete with its own gearbox, Ref. 10KB/260. The electrical work here is quite simple.

The two small brushes and two leads out on the H.T. side are scrapped altogether, whilst on the L.T. end the field wires and main leads are unsoldered from the brush holders. A terminal block with four terminals is fitted across the flats of the carcass. Use the top side so that it will be easy to get at later on. The field wires go to two of the terminals, and brush holders to the remaining two. Should you not be familiar with these motors, the 12 V end is

the end where the commutator is of heavy construction and the brush holders not insulated. Use stout wire about 16 s.w.g. to couple brush holders to terminals. Coupling this unit to the rear axle called for more planning, and also gave thought for a further refinement here. A way of disengaging the axle from the motion was required, as it would be necessary to move the crane without power on. Even with it parked in one corner, the floor still had to have an occasional polish! Three old brass gears,

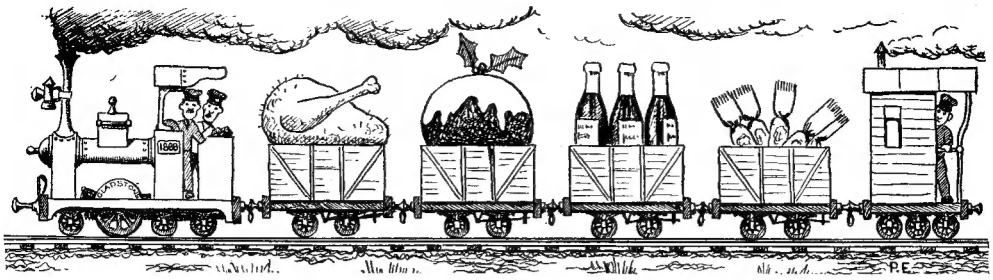


The model crane with cab removed and gib elevated

each approximately 1½ in. diameter by $\frac{3}{16}$ in. thick were obtained, and luckily they were only flat pressed gears with a $\frac{7}{16}$-in. hole in the centre; so one was bushed down to ¼ in. with a boss left protruding, and fitted on to a ¼-in. shaft which replaced the original hollow shaft in the gearbox. Next, attention was paid to the rear axle part. Two brass flanges were turned up slightly smaller than the gears, with a $\frac{7}{8}$ in. diameter boss left on one side ½ in. long, and drilled out and reamed $\frac{7}{16}$ in. The gears were carefully lined up side by side, one flange put on each side, and the whole assembly put on a $\frac{7}{16}$ in. shaft for aligning, and then drilled and riveted together with four ¼-in. iron rivets. After removing the shaft and passing the reamer through the lot, it left a gear ⅜-in. wide with a nice long boss on each side, all a nice sliding fit on the axle. A brass collar, $\frac{7}{8}$ in. diameter and ½ in. long, is bored out $\frac{7}{16}$ in. and fitted with two 3/32-in. silver-steel pins which engage with two holes drilled in the boss at one end of the gear. The gear is then spring-loaded by means of a small compression spring on the shaft, butting against a steel thrust collar which in turn comes up against the bush in the axle bearing bracket. A similar collar is also fitted against the bearing on other end of the shaft. The shaft itself is $\frac{7}{16}$-in. silver-steel turned down to $\frac{5}{16}$ in. diameter outside the bearings to take the wheels, one of which is fixed whilst the other is left free to revolve. It is retained by a small brass collar and Allen screw similar to the front wheels. A bracket bolted on the back edge carries a shaft and control, known also as a "click" plate, and with a toggle lever inside serves to slide the gear along out of engagement with the pins, but not out of mesh with the motor gear. That was the idea of using two gears side by side. The motor now has only to be positioned, so that the gears mesh together, and is bolted down with four 2-B.A. bolts.

A bracket is fixed on end in the centre to carry the 12-pin multiple plug which must be of the heavy variety, and has contacts ¼ in. wide, $\frac{1}{16}$ in. thick, of course, also ex-W.D., sometimes referred to as "Jones' plugs."

(To be continued)



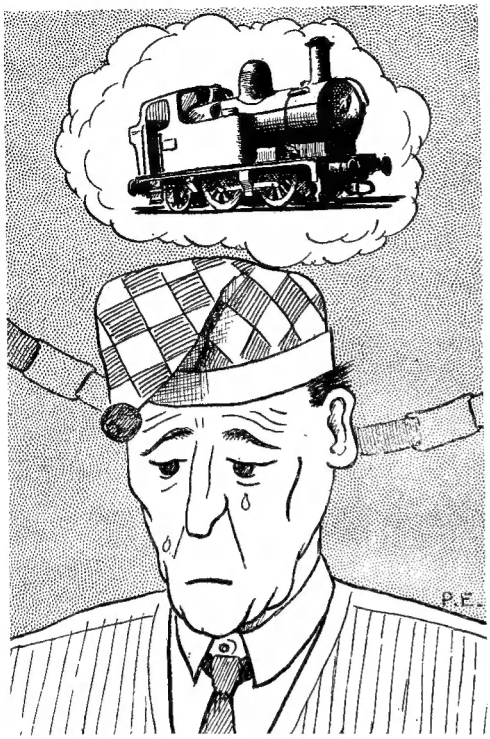
DON'T TALK SHOP AT CHRISTMAS!

by "Enoch"

THE prophet, it is said, is not without honour, except in his own country, and by the same token, a model engineer is not without honour, except in his own family. This is particularly true at times of festivity and jubilation. For instance, when cousin Frank came to spend Christmas with us, I looked forward to taking advantage of this occasion—knowing him to be at least a lukewarm enthusiast, and therefore a potential convert to the noble art of model engineering—of initiating him into the mysteries of the workshop, the thrills of running machinery, flying chips and the hiss of live steam; but no!—my hopes were dashed when it was decreed by the domestic gods that not only entering the workshop, but even talking about it—at Christmas, of all times!—was definitely taboo. Cousin Frank, it was announced, was coming here to enjoy himself, and mustn't be bored by all this model nonsense; any spare time which happened to occur in the intervals between official festivities was to be occupied in showing him the sights of our salubrious suburb—which, in our particular case, consisted mainly of such archeological curiosities as the local hostelry, the girl in the tobacconists' (whose vocabulary seemed strangely to be confined to two cryptic words "Turkish only"), Mrs. Smith's wingless chickens, and the spot where the doodlebug fell in '44.

"Was I the life and soul of the party?"

My wife, whose querulous and thinly veiled sarcasm I have to endure throughout the year, evinced an even more open hostility to my model engineering activities at Christmas, while the children became overtly devoid of inhibitions—knowing that corporal punishment is suspended at this period of peace and goodwill, or at least while the guests are present—and took a ghoulish delight in my discomfiture in being exiled from the workshop at this festive season. One of my guests, Jimmy Crosshead, is a fellow member of our local M.E. Society, and as keen as mustard, but my hopes of getting in a word or two edgewise with him



Christmas cheer!—thoughts of the 0-4-2

were doomed to disappointment. He is always telling me that Mrs. Crosshead is an ideal model engineering wife, but I begin to doubt it, for on this occasion her honeyed injunction: "Now please don't talk shop today, Jimmy," effectively guillotined any attempt at conversation on these lines.

Why is it such a crime for model engineers to talk shop in the presence of (alleged) convivial company? Other kinds of enthusiasts are apparently not subject to this veto. Nobody ever tries to stop the amateur angler from relating the thrilling story of the one which "just got away," or the philatelist from explaining how the gem of his collection *nearly* became valuable; the efforts of amateur poets, crooners, saxophonists, comedians, conjurers and politicians, even if not really enjoyed, are at least tolerated—or shall we say endured? Even the amateur bird-watcher may get a chance to indulge his hobby at Christmas—the model engineer alone may be prevented from discoursing on his pet topics or demonstrating his achievements. The workshop is out of bounds, technical terms are banned as unfit for polite conversation, and the only tool he is allowed to use on Christmas Day is a tin-opener.

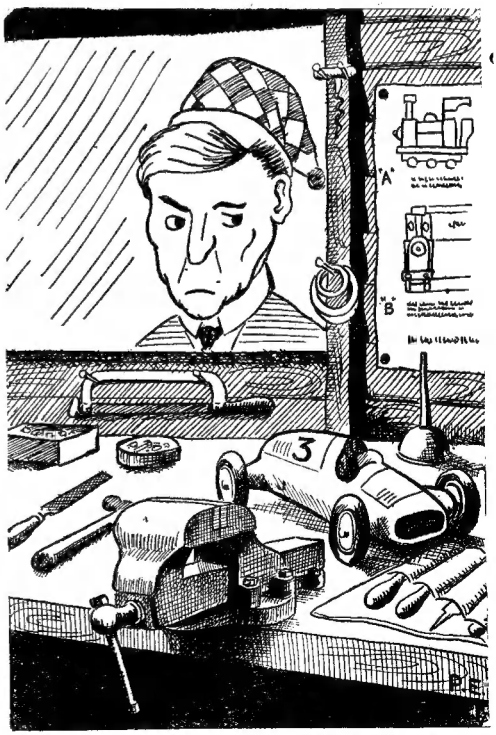
I did manage to find a shred of solace in the few mechanical toys I had surreptitiously contrived to smuggle into the kiddies' stockings, though strangely enough, the actual recipients seemed to take a dim view of them, preferring to play with their G-men outfits or read the adventures of Dick Barton. The adult members of the party were shocked, and the adolescents superciliously amused, to find me squatting on the floor, explaining at length to a circle of obviously bored youngsters how the clockwork locomotive chasing its tail on its circular tin track could be vastly improved by converting it to run on steam, or better still, by fitting it with a gas turbine.

I once made a valiant effort to brighten up the Christmas festivities by driving my 3½ in. gauge "Pacific" into the dining-room, with a sprig of holly on the smokebox, and a bunch of mistletoe over the cab. Was I acclaimed as the life and soul of the party? No! All I got for my pains was a protest that the hot cinders had ruined the carpet, and the smoke had set Auntie's asthma off again.

My family—base ingrates! never think of taking into account all that I have done in my workshop to add to their material comfort and convenience. What of the electric alarm clock, (which sometimes works), the toasting-fork, the wool winder and the emergency cooking stove (utilising the blowlamp out of my flash steamer) for use when there is a simultaneous gas failure and electrical "load shedding." All these things are just taken for granted; one often hears snatches of a domestic conversation which goes something like this:

"It must be nice to have a handy man about the house, who can make all these clever gadgets and put things right when they go wrong."

(*Continued on next page*)



"Our shed"—on the outside, looking in

The Model Wife

by Betty W. Arthur-Brand

PERHAPS, you too have stood, like Mrs. Jones, clutching ■ chopper and eyeing a small but intricate piece of machinery with desperate resolve. Perhaps, your hand also has been stayed in its murderous flight by ■ male voice from the kitchen.

"Come and see this, Emmy, it works now!"

Emmy Jones sighed. She laid down the chopper. Her tiny kitchen seemed full of 150-watt light, oil, nuts, bolts, and Mr. Jones. Here and there ■ pan or jam-jar lurked apologetically behind assorted tools, while ■ soldering-iron glowed smugly at the cooling percolator it had displaced from the gas ring.

A familiar scene.

"See, Emmy!"

Mr. Jones jiggled something, made ■ cracking gesture with a leather thong and the kitchen reverberated with the sound of ■ million demented bumble-bees.

Emmy shrieked "You'll blow us to perdition."

"Glow-plug ignition?" he roared eagerly—"I'll explain afterwards."

The little engine reached its peak hysteria, hiccoughed, and was still. Into the pulsating silence which followed, Mr. Jones injected the reverent whisper—"Did you hear that?" He might have been Bell at the end of the first telephone.

A large flake of plaster drifted from ceiling to soup. The next-door neighbour banged on the wall and Mrs. Jones burst into tears.

Her husband smiled indulgently. Over-excited, no doubt. He patted her.

Poor child, her proud spirit was almost broken.

Mr. Jones was an amateur model engineer. He had made a model traction engine. He was driving his wife nuts. The last straw, in the guise of ■ washer in the gooseberry preserve, formed her resolve. She would do something.

Well, first she tried losing his tools. He bought new ones. She tried the frail approach and said the noise gave her ■ headache. He bought her aspirin. She tried the feminine approach and said he did not love her. He named the traction engine "Emmy." She tried the tough approach and said he just couldn't use the kitchen. He moved his stuff into the dining room. She tried the wistful approach and said she was "so lonely." He bought her a bound volume of THE MODEL ENGINEER. So, one night, she was driven to read it.

At first, phrases like "rear induction inlet orifice" and "rotary disc induction valve" just made her pleasantly drowsy; but after ■ while, ■ faintly growing interest made her stop wondering what the judge would say when she named ■ model traction engine as co-respondent.

While Emmy battled with basic engineering principles, Joe gloated over his little traction engine, taking bits away and putting them back on again. Emmy loathed it quietly. What had it got that she had not?

She read on. The great idea arrived when she was thinking about Christmas presents. An ambitious scheme she realised, but not (and she giggled) impossible.

After that, the Yuletide arrangements became more of ■ mystery than ever to Joe. When he came home from the office there would be a frantic scramble and rustling of paper as Emmy hid her secret in some recess.

Sometimes he teased her about it ■ he paused in his traction titivation. Once he found wood shavings round her chair.

"?" he intimated.

"Knitting too quickly," said Emmy briefly. "Splinters from the needles."

Then it was Christmas Day. Emmy exclaimed over her new brooch. A diamante traction engine. My, my! But she smiled charmingly, embraced ■ rather anxious Joe and handed over the rather bulky parcel that had perplexed him so long.

He opened it eagerly—a box. Just ■ box, but ■ beautifully proportioned, smoothed and varnished box, with a gleaming, complicated lock. The chrome letters "Emmy" flashed from its lid.

"You made it!" realised Joe. "All by yourself, lock and all. You're interested at last. Oh, Emmy!"

"Let's put it in," she suggested innocently and, as the lid clicked over Emmy II, "Ooh, see what I've done. Now I really must find the key. I've er, mislaid it, you know."

"Don't worry about that," cried Joe, "Now we'll make something together," and he never noticed that the traction engine's little box looked remarkably like ■ coffin. But, firmly echoing "together," Emmy did—and smiled.

Don't Talk Shop at Christmas!

(*Continued from page 785*

"Oh, yes, but it has its drawbacks; I often wish he was ■ normal human being like *your* husband!" It seems that we model engineers are for ever fated to be misunderstood. What is the remedy—if any?

Perhaps something might be done by scientific selection of wives, not to mention families and friends. Prospective wives of model engineers might be given a psychological examination to make sure that they had never been frightened in infancy by ■ model racing boat or an "M.E." road roller; ■ carefully selected questionnaire could be applied to ensure that they were not of the type which refer to models as "all this rubbish," to the workshop as "your old muck room" or to twist drills ■ "those twiggly nails." The existence of possible allergies to such things as petrol fumes, castings on the drawing-room mantelpiece, or metal shavings on the stair carpet, might also be ascertained. By such methods one might ensure that model engineers would ultimately receive the appreciation they deserve, and breed ■ race of enthusiastic sympathisers.

A horrid thought has just occurred to me: suppose my wife should happen to read all this!

Novices' Corner

THE purpose of these articles is to show, quite simply, how hand and machine tools are used in doing ordinary work in the small workshop.

These notes will be of a strictly practical nature, and though each instalment may at first deal with but a single aspect of workshop practice, eventually this information will, it is hoped, prove helpful when descriptions are given of making useful articles of equipment, as well as models and other light engineering products.

At the outset, it is fully realised that it will not be possible always to interest all sections of those taking up either model making or some more general kind of mechanical work. At one end of the scale are those who have just reached an age which makes the establishment of a small workshop possible, and at the other, are older members with a mechanical turn of mind, who have had, maybe, a scientific training and are prepared to spend some time and money in equipping a workshop which will enable them to spend their leisure in indulging in a satisfying hobby. All these, according to their ability and resources, will graduate from the novitiate stage, and will then be able to take advantage of the more advanced articles appearing in THE MODEL ENGINEER, contributed by experienced writers who cover a wide field of engineering practice. The scope of the present series of articles will be largely determined by the views expressed by a number of amateurs both young and old who are establishing workshops, for with these, close contact will be maintained, and their workshop problems as far as possible dealt with.

Further, it will be helpful if readers will make known their difficulties in order that these may be discussed for the benefit of others.

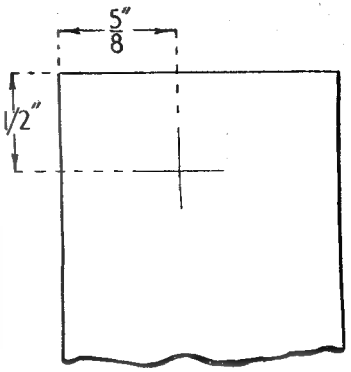


Fig. 1. *Cross-line, indicating the position of a drilling centre*

At this point, we would emphasise the importance of accuracy, even slavish accuracy, in carrying out all ordinary workshop operations, for although this may at times seem unnecessary and even tiresome, nevertheless, in the end this will be amply repaid not only in the satisfaction gained from contemplating a piece of accurately made work, but any addition made to an original mechanism and the construction and fitting of new parts will be greatly simplified.

Fig. 3. *A scriber with a detachable point*

Following these introductory remarks in setting out our object, let us now consider some of the more elementary, but none the less, important practical details which constantly occur when making things in the small workshop.

Preparing Work for Drilling

Although there is no particular difficulty in drilling a hole, to drill a hole in exactly the right position, without the use of guides or jigs, requires some skill and care. As this problem constantly occurs in all mechanical work, it may be profitable to consider it in detail with a view to avoiding the waste of time and dissatisfaction caused by a hole drilled out of place.

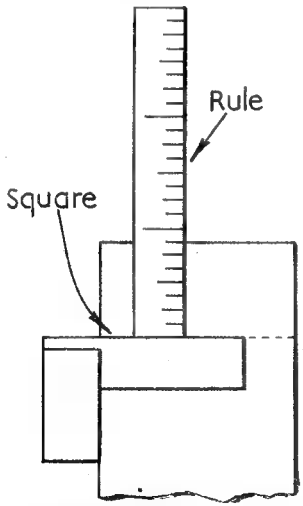


Fig. 2. *Setting the square from the edge of the work*

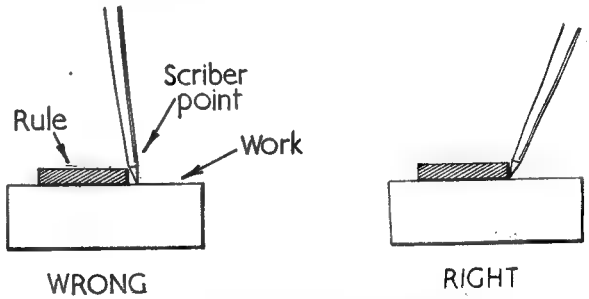


Fig. 4. *Scribing a line from a rule*

It is customary to denote the position of a drill hole by the point of intersection of two lines drawn at right-angles to one another, each line usually being scribed at a definite distance from the edges of the work as represented in Fig. 1.

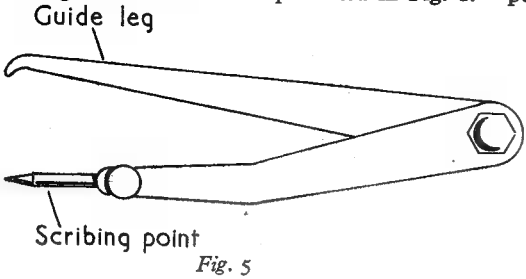


Fig. 5

One method of doing this is to use a try-square, and to set it to the correct distance from the edge of the work by means of a rule as shown in Fig. 2. For drawing the lines a scriber is used, and as shown in Fig. 3, this is a tool with a fine sharp point. To enable the scriber to draw clear lines, and without excessive pressure being exerted, it is essential that the point should be kept sharp by occasional rubbing on an oil-stone until the tip feels sharp when touched with the finger.

As illustrated in Fig. 4, it is important to hold the scriber to the rule in the right way, otherwise the scribed line may be drawn out of place.

No attempt should be made to force a deeply-cut line, for this will probably result in displacing the rule and causing inaccurate work.

As the scribed lines may not show up well, particularly on harder materials, it is advisable to treat the surface of the work with some form of paint preparatory to marking it out. For this purpose, Talbot Blue, obtainable from Messrs. Buck & Ryan and other leading tool merchants, is an excellent preparation as it dries quickly and adheres firmly to metal surfaces, although it can be readily removed after use with a rag moistened with methylated spirit.

An alternative method of scribing the lines to denote the drilling centre, and one less liable to error, is to use the jenny calipers for this purpose.

This too, as shown in Fig. 5, has a pointed scribing leg and a curved guide leg which is held in contact with the work. As illustrated in Fig. 6. The caliper is usually set by placing

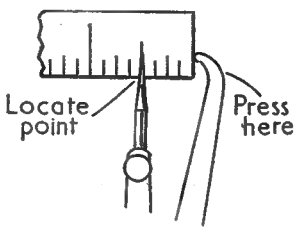


Fig. 6

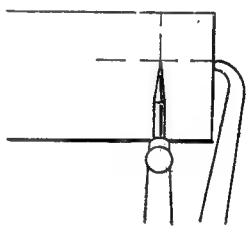


Fig. 7

the scribing point in the required rule graduation, and then closing the guide leg against the end of the rule. When set, the jenny is applied to the work and two lines are scribed at right-angles to one another as represented in Fig. 7.

The Turner and the Carpenter by H.O.S.

(*With apologies to the late Lewis Carroll*)

A turner and a carpenter
Once joined the happy band
Of model engineers to see
If they could understand
The way a railway engine works
They thought it would be grand.

They said they'd make a little one
To " words and music " so
They studied notes and 'ints and tips
On how to make one go
This turner and this carpenter
Were very far from slow.

" Do you suppose " the turner said
" We your old man could touch
To find the cash to buy the tools
the lathe, the drills and such ? "
" I doubt it," said the carpenter
" I doubt it, very much."

They thought they'd try a four-wheel job
The simplest loco yet
The axle steel frame plates and brass
The turner he could get
The carpenter the patterns made
For little " Juliet."

" The time has come " the turner said
" To work on many things
The safety-valve, the water-gauge,
The driving wheels and springs.
And how to make the boiler hot
To give our loco wings."

The job was done without delay
And tried out on the track
The turner and the carpenter
Both seated on the back
With Mrs. T. and Mrs. C.
Their children Jill and Jack.

Now readers, who have read thus far
Don't think that you must be
A turner or a carpenter
Or an " L.B.S.C."
It may be building locos
Is just your cup of tea.

So why not join a model club
And see what you can do ?
They'll show you how to cut the frames
And how to tap and screw
Perhaps at next year's model show
Your own will be on view.

A ¾-in. Scale G.W.R. "King" Class Locomotive

by F. Cottam

THE following is a description of the construction of my ¾-in. scale "King" class locomotive which was awarded the "Curwen" Cup and a silver medal at the 1948 "M.E." Exhibition.

Early in 1937, I decided to build this engine, and a Greenly 17/32-in. scale outline drawing of engine and tender was purchased. I also acquired Swindon blueprints of the bogie frames and tender to ⅜-in. scale.

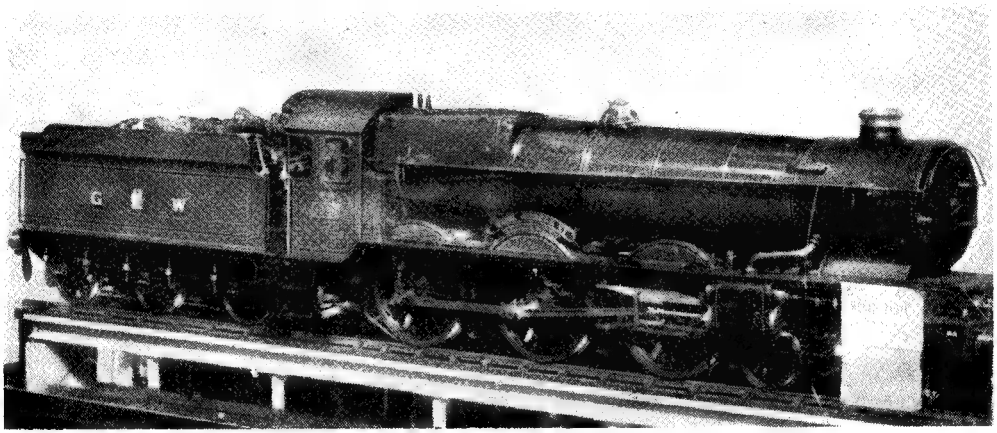
From these prints my drawings were made. I have access to the full-sized "Kings," and throughout the designing and building of my locomotive have been able to measure up most of the details. My drawings were finished during Autumn, 1937; but they have been modified during construction, as there were snags. Some improvements were made as the work progressed.

Next, ⅛-in. frame steel, Bassett-Lowke wheel castings (coupled-wheel castings 10d. each, in those days!) and cylinder castings from Jackson, of York, were obtained. "L.B.S.C.'s" methods were used on these items and no difficulties were experienced. The four cylinders are 1 1/64 in. bore by 1⅜ in. stroke, and were finished with an expanding reamer.

Axleboxes and horns are of steel. Horns are two-piece, built from ⅜-in. × ⅛-in. angle with webs brazed in. Axleboxes are also two-piece, the keep being kept in position by a transverse ⅛-in. pin which also passes through the top of the spring centre hanger. Split phosphor-bronze bushes are fitted. Lubrication is attended to by "trimmings" from oil-boxes on the footplate.

The method used to bore the axleboxes, crank webs, coupling-rods and crankpin holes with accuracy, was described by myself in THE MODEL ENGINEER in October, 1944, under the heading "Notes of Small Locomotive Construction."

The crank-axle was built up from ¾-in. round mild-steel and ¼-in. × 1-in. flat steel. All coupled axles are hollow, being drilled ¼ in., which corresponds to 4 in. on the full-size locomotive, and are turned to ⅝ in. diameter.



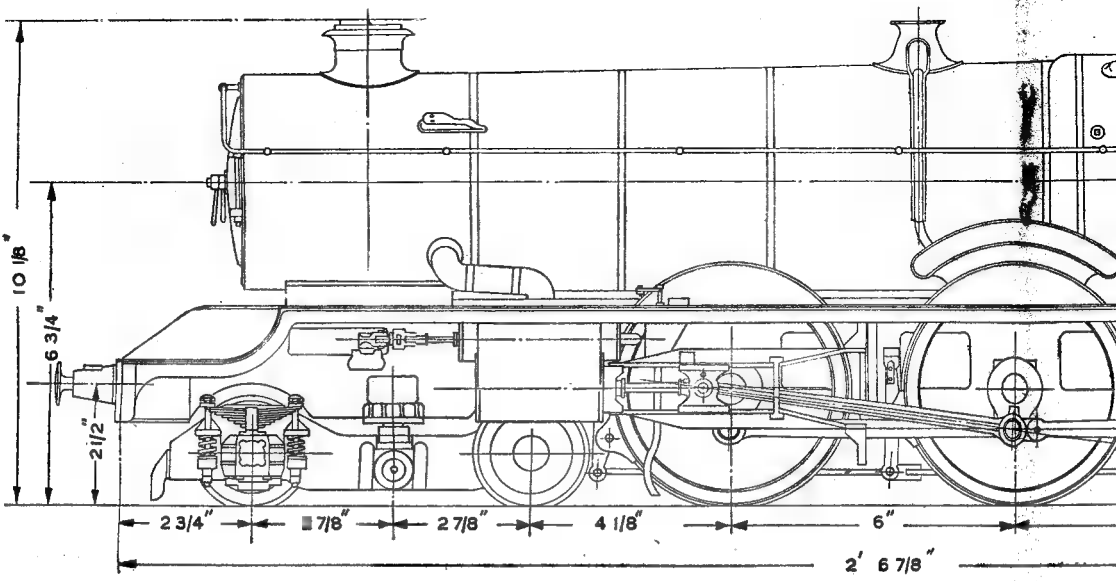
Mr. Cottam's scale G.W.R. "King" class locomotive and tender

Springs on bogie and coupled axleboxes are built up from 22-gauge × ¼-in. phosphor-bronze strip. As they were too strong, the intermediate leaves were drilled with a series of ⅛-in. holes to give more flexibility. Coupled-wheel springs have 16 leaves, bogie 12. Compensating gear is not fitted as this is not now a feature of the big engine.

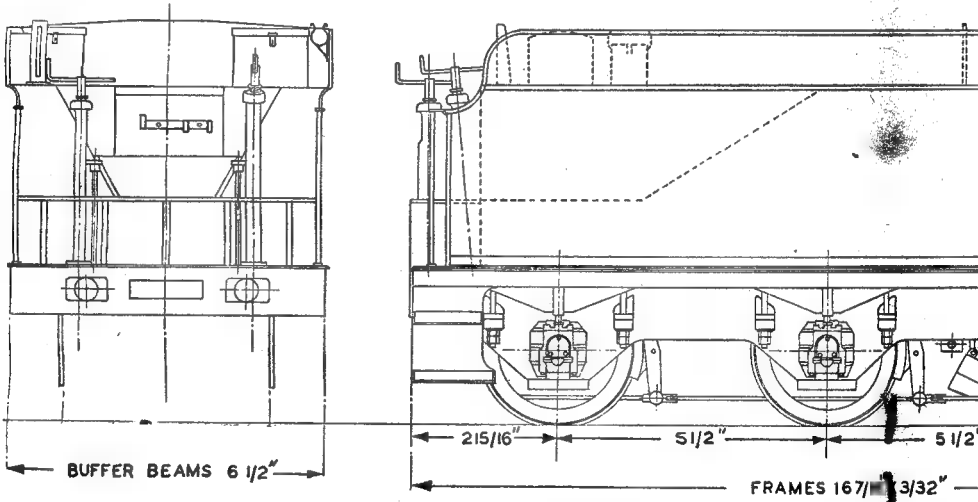
Connecting-rods, inside and out, also coupling-rods, crossheads and slide-bars are cut from solid steel. Crossheads are fitted with brass liners on slides.

Cylinders are of phosphor-bronze, with slide valves (⅝-in. travel). Soft packing is used on pistons. Piston-rods are tapered into the crossheads and fitted with flat taper cotters. Gudgeon-pins are case-hardened. Drain-cocks, with ball valves are operated from the cab. Glands on inside cylinders are of screwed, outside, studded type. Two snifting-valves are fitted on outside steam-chests under footplate. They connect to the inside cylinders *via* the main steam pipes.

Valve-gear was rather a problem. The full-sized could not be exactly copied, as slide valves are used on my engine, whereas piston valves are employed on the full-sized locomotive. Besides the valve-gear between frames at front end are inside steam and exhaust pipes, outside cylinders exhaust pipes, vacuum pump, motion-



Elevation and front end view of the scale mode

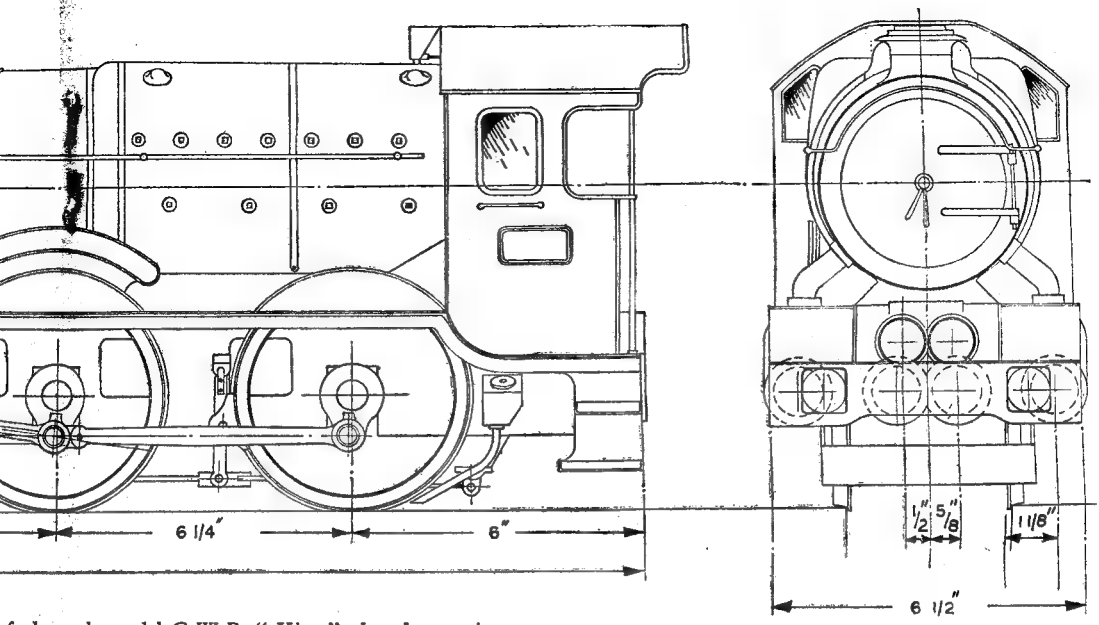


End views and elevation of the tender for th

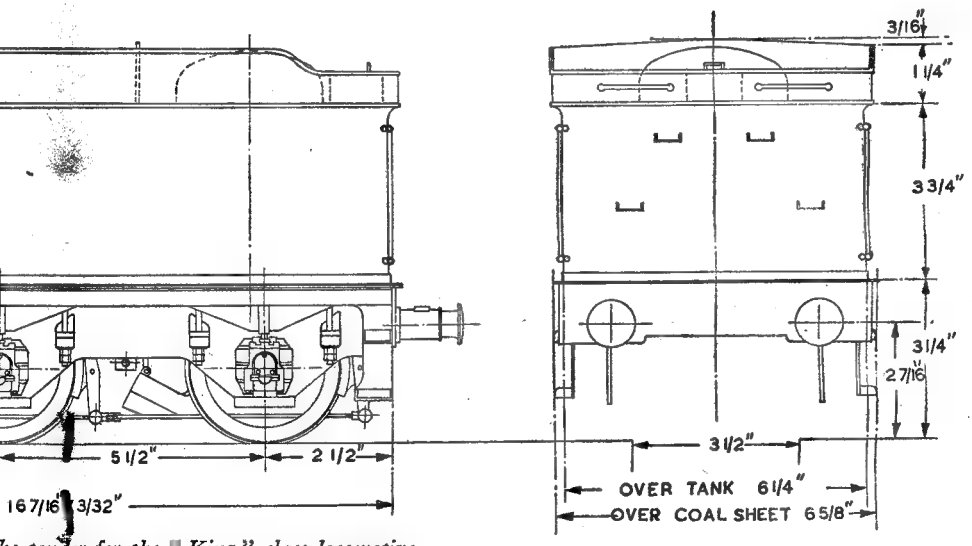
plate, and bogie stretcher ■ well ■ crank-axle, connecting-rods, slide-bars, etc. All these parts were eventually schemed out so that the various components missed each other and, at the same time, could be assembled. Valve-gear is Walschaerts, as on the full-size locomotive, but on the small edition, valve spindle and radius-rod connections on combining-lever had to be reversed, as slide valves are used. All pins in the valve-gear are case-hardened and lapped, and run in hardened and lapped silver-steel bushes. Expansion-links, of box type, and the two pairs of steel quadrant-blocks are all hardened and polished.

Cut-off is 75 per cent. in full gear and will notch up to 25 per cent.

The main stretcher, which houses bearings for expansion-links and auxiliary weighbar



of the scale model G.W.R. "King" class locomotive



he tender for the "King" class locomotive

shafts, is built up from brass sheet, silver-soldered, to simulate a casting. The big engine was fitted with a cast main stretcher, but as these frequently cracked, owing probably to the continual twisting of the frames, while the engine was in motion, they are being replaced by a fabricated welded-steel stretcher.

An interesting feature of the G. W. Walschaerts gear is that the front, or auxiliary weighbar shaft is in two parts, left- and right-hand, each having a reversing arm and reach-rod to the main weigh-bar shaft. In the event of one side of the engine becoming defective, the reach-rod can be disconnected, after putting engine in mid-gear; the defective side can then be secured by an emergency bracket, and the engine worked home on the sound side. Incidentally, this will not completely cut off the steam supply to the

defective side unless the inside connecting-rod or guide link and combining lever are also disconnected.

This feature is copied on the small edition. Steam and exhaust connections to inside engines, and exhaust from outside engines, may be seen in the sectional drawing. The inside cylinder exhaust pipe is made a slide fit into the cylinder block and secured by a flange to the manifold under the saddle. My original drawings provided for the exhaust pipe to screw into the cylinder block ; but later reflection revealed that while the parts could easily be made and fitted on the bench, they could not be assembled between frames, unless some mice, trained as locomotive fitters, were available, and I have not reached that stage yet !

Outside steam pipes, $\frac{1}{4}$ in. diameter, follow full-size design, passing through the sides of the smokebox with a couple of nice curves down to the cylinders. My steam pipes are enclosed in $\frac{1}{2}$ in. diameter 22-gauge jackets. Most models with this feature that I have seen have had the outside pipes " dolled up " with string, to give the required diameter, or have been dummies with the steam pipes between frames. The jackets are easy to make if full-size practice is followed. On my locomotive, each jacket is in six parts, two halves on each bend, formed on a special die, and two semicircular halves along the straight part, the whole being secured by two $\frac{1}{8}$-in. bands which pass around the jacket, tightened up by 12-B.A. screws and nuts behind.

Twin water pumps, $\frac{1}{2}$ in. $\times$ $\frac{1}{2}$ in., are fitted in front of and are driven by eccentrics on centre coupled axle. They follow usual practice and are built up from phosphor-bronze rod. A feature which may be of interest is the air bottle between pump delivery and boiler. This is a $1\frac{1}{2}$-in. length of $\frac{1}{2}$-in. diameter tube, closed at top by a silver-soldered blank. The bottom is connected to the pump delivery pipe. The use of the air bottle prevents " water hammer " ; water passes into boiler, or comes from by-pass in a steady stream instead of a series of gulps.

The bogie consists of about one hundred and eighty separate parts. The stretcher between frames was built up. Side control springs are fitted.

I have never been impressed by seeing locomotives at track meetings spouting oil over smokebox, driver and passengers, to say nothing of the track. While efficient lubrication is essential, it should not be wasteful. With this in mind, I made some experiments with a G.W.-type sight-feed lubricator, which does not waste oil, has no clacks, can be controlled and is always in sight of the driver. My locomotive, with four cylinders, gets one drop of oil per minute. Examination after about 10 hours' running revealed that cylinders and pistons are in fine condition while little oil is used. The lubricator was described in THE MODEL ENGINEER, November 27th, 1947, under the heading " Oil in Small Doses."

The boiler has a parallel barrel with inner and outer firebox wrappers tapered at top and sides. Four $\frac{3}{4}$-in. superheater flues are fitted and carry $\frac{1}{4}$-in. diameter elements. $\frac{1}{2}$-in. and $\frac{3}{8}$-in. fire-tubes are fitted. A three-jet ring blower is fitted to the blastpipe cap. Jets can be removed with a small box-spanner when they require cleaning. The boiler has top-feeds for injectors and pump. Feed clacks are fitted to left-hand injector, also to a manifold under right-hand side of cab. This contains clacks for right-hand injector and pump, also the by-pass valve.

The " pop " safety-valve is set to lift at 75 lb. pressure.

The funnel was turned from a casting, the copper cap being beaten up from 16-gauge copper in two parts, top and curved parts, then brazed, turned to size and polished.

Lagging plate around barrel is of 22-gauge brass and was taper-rolled on a home-made rolling machine, which was later adapted to hot-roll the cab floor chequer-plates.

The firebox originally contained a brick arch, but this was partly removed, as steaming was better without it ; the arch was moulded in position from " Pyruma " which sets very hard.

Stays, roof and side, are of 5/32-in. phosphor-bronze and number 154. A fusible plug is fitted ; this feature is recommended especially where there is any soft solder in the boiler, and was described in THE MODEL ENGINEER for November 11, 1948.

Owing to the taper sides of the inner and outer shells of the firebox, the usual practice of inserting the inner firebox, complete with tubes from the back end of firebox, then brazing the back-plate and foundation ring, could not be followed, as front end of the inner box is wider than the back end of the outer firebox. Complete inner and outer fireboxes, tubes, sides and back of the foundation ring were brazed up. Throatplate was brazed to barrel. The two parts were fitted together, then the outer wrapper was silver-soldered to the throatplate, also front of foundation ring and front tube-plate with tubes silver-soldered in.

The boiler is brazed or silver-soldered, while the stays are screwed, nutted, and caulked with soft solder. The complete boiler, was then handed over to Mr. McGillivray, Harrow and Wembley Society's official boiler-burster, who certified it O.K. after a 180-lb. hydraulic and 150-lb. steam test had been applied to it.

Two injectors are fitted. Maybe I was unlucky with these, as nearly two months passed before they could be made to work.

It was decided to fit the G.W.-type of vacuum brake, which differs from the standard brake mainly in the provision of a crosshead pump and vacuum-retaining valve. The brake is fitted to engine and tender with provision for coupling to train from a union under the tender buffer beam.

Many experiments were made with brake cylinders, ejector (on right-hand side firebox), crosshead vacuum-pump (on right-hand inside crosshead) vacuum retaining valve (under footplate right-hand front end) and duplex vacuum gauge in cab. All parts worked well on bench test, but have not been tested on the finished engine. It is considered that the brake cylinders should be larger, $1\frac{3}{4}$ in. instead of $1\frac{1}{4}$ in. diameter, to give greater power ; but this could not be done without rebuilding the engine, as the brake cylinders at present occupy all available space under the cab and front of tender.

(To be continued)

Removable Boiler Flues

WE have received another interesting letter from Mr. V. H. Messer, of Hawthorn, South Australia, who writes: "The articles by Mr. Ronald Clark, on 'Traction Engines not so Well Known' are indeed interesting.

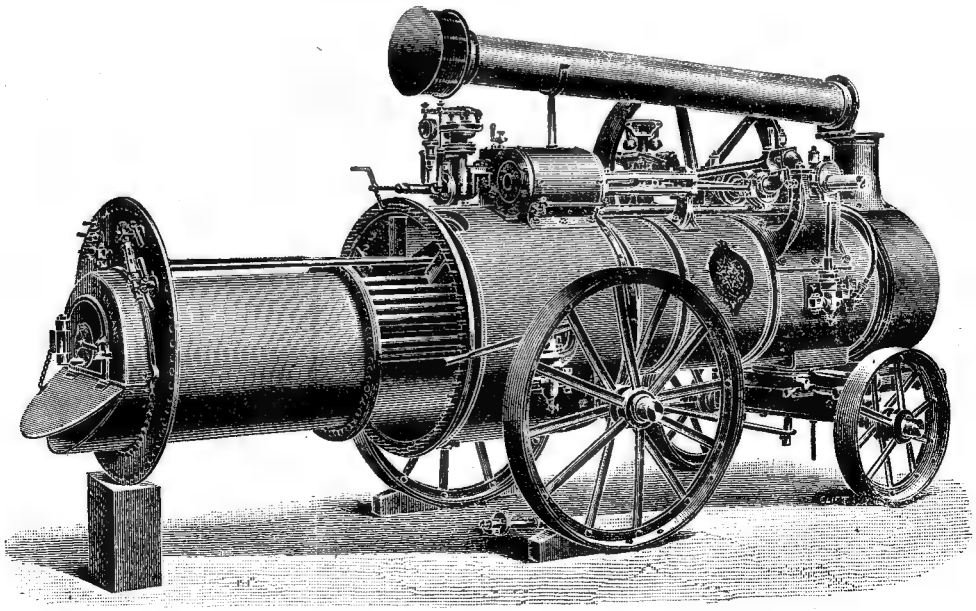
"Although Robey of Lincoln did not, it seems, build traction engines, they did produce portables, and I wonder if Mr. Clark, or any reader, has seen 'in the flesh' an example of their portable with the removable firebox and tubes.

"I am sending an old photograph, the date of which is not known, taken in Queensland, also a page from Robey's catalogue of 1899, illustrating this wonderful (?) idea. I should think that the job of unscrewing all those nuts and studs on frontplate, stays and tubeplate after some years of use, would be a real knuckle-tearing one! A rough count, allowing for the same number at each end, adds up to 70!"

The photograph reproduced above shows a Robey portable at work driving an open-air sawmill, and there can be little doubt that the engine is one of the "removable-flue" variety.

The other illustration, taken from the man-

(*Continued on page* 797)



PETROL ENGINE TOPICS

*A General-Purpose 15-c.c. Two-Stroke

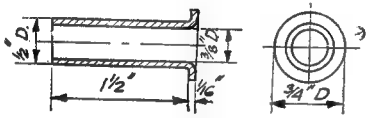
An Elementary Exercise in Model Petrol Engine Construction

by Edgar T. Westbury

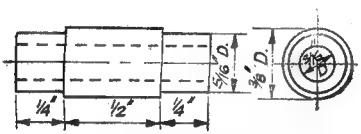
IN reply to the comments of one or two readers regarding the fitting of the cylinder liner, it should not be necessary to give any further attention to the bore after insertion; with a pressed or shrunk-in liner, on the other hand, some distortion of the bore is almost invariably encountered, and considerable lapping may be necessary to correct this. One result of this is that the abrasive gets into odd corners of the ports and passages, and it is often difficult to be quite sure of its complete removal, after the operation is completed. I often encounter cases where cylinders and pistons become badly scored in running, and the symptoms suggest that something worse than metal swarf has been at work; it is quite probable that a trace of abrasive has been left in some inaccessible chink when the engine was assembled, and has eventually worked into the cylinder.

It is sometimes suggested that lapping, or indeed any abrasive process, is inadvisable for finishing working surfaces, on the grounds that particles of abrasive get worked into the pores of the metal and remain active indefinitely, resulting in rapid wear of the surfaces which come in contact with them. I have found no evidence of this, provided that the most scrupulous care is taken in cleaning the parts after lapping; and the extent to which abrasive processes are employed in precision engineering of all kinds gives little support to the theory. We know that there *are* microscopic pores and crevices in the hardest and closest-grained materials, but it would have to be a very minute grain of abrasive to find lodgment in them. Where evidence of continued abrasive action does occur, I think it is more often due to lack of care in the cleaning of the surfaces and interstices after the finishing process.

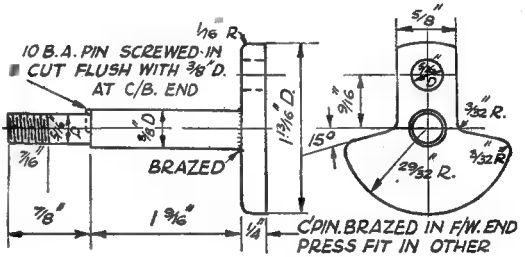
Before leaving the description of the cylinder liner, it should be noted that the depth of the rim should be very slightly greater than that of the recess in the head into which it fits, so that the end of the liner forms the joint face. Should the recess be made too deep, however, the bottom surface of the head may be machined or lapped down to ensure a slight clearance at this point; not more than a few thousandths of an inch is necessary. The end face of the liner should be accurately machined, and may be lapped into the recess before fitting the cylinder-head studs, in order to ensure a perfect metal-to-metal joint.



Main bearing bushes (2 off, bronze)



Crankpin (roughed out and brazed into flywheel end half-crankshaft)



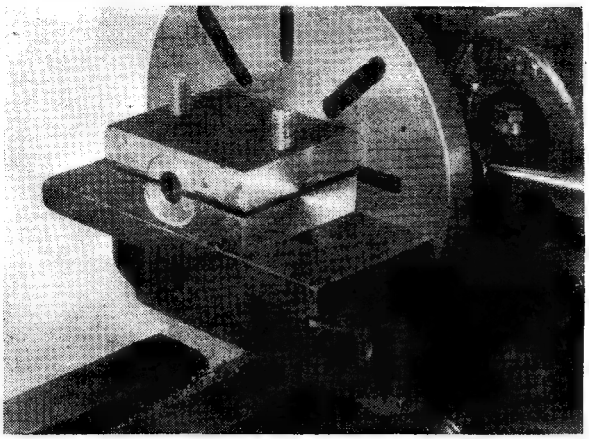
Details of half-crankshaft (contact-breaker end shown)

Main Bearings

It is advisable to make these and fit them to the crankcase housings before making the crankshaft, so that the latter can be fitted to them. The procedure in machining such bushes is quite straightforward, and where possible, it is best to make them from bronze stock, so that they can be bored and turned at one setting. If this is not practicable, bore and ream them, and rough down the outside where it can be reached, and then press them on a true-running mandrel to finish the outside exactly concentric with the bore. An interference fit of about 0.001 in. is quite sufficient to ensure permanent tightness of the bush in its housing.

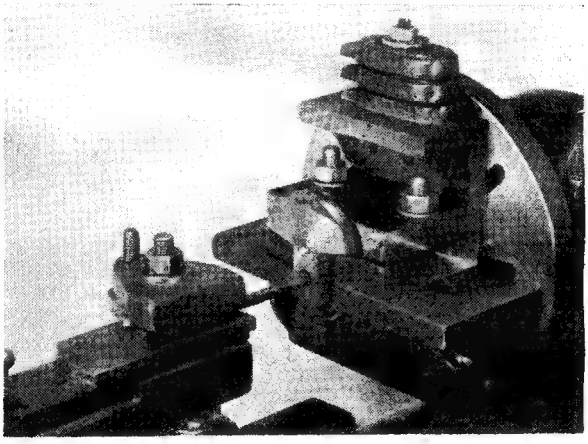
The flanged end face of the bush should be machined to a good finish, and a liberal radius or chamfer put in the mouth of the bore to clear the fillet on the crankshaft. To insert the bush, the use of a ⅜-in. bolt is advised, rather than using

*Continued from page 722, "M.E.," December 8th, 1949.



Clamping plate for crank journals (after boring, and before eccentric setting)

the vice as a press, and machined washers should be put on either end to avoid marking either the flange of the bush or the outer face of the housing. After inserting the bushes, the crankcase halves should be assembled, and a ⅜-in. reamer run right through both bushes to ensure correct alignment.

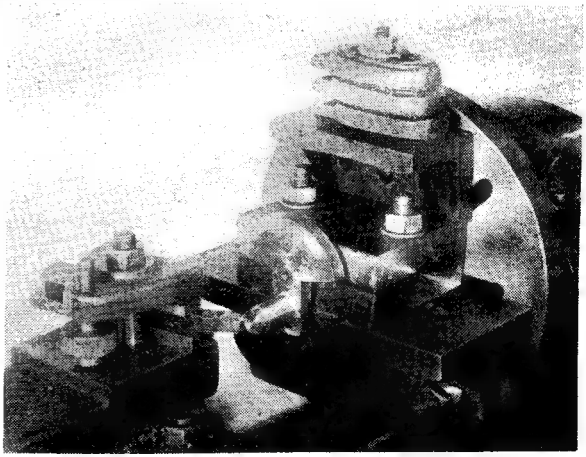


Clamp with half-shaft in position, set over for boring crankpin socket

Crankshaft Construction

The methods of machining or fabricating crankshafts have been dealt with so many times in "Petrol Engine Topics" that some readers may consider that further description is but vain repetition. There are, however, one or two points about the way this particular specimen was made which may be of interest. It has already been explained that it is practicable to make a satisfactory crankshaft of this type by pressing both the journals and crankpins into the webs, provided that the fit and finish of the mating parts is beyond reproach; but there are many pitfalls in this method of fabrication, and even if the machining is perfect, the lack of a suitable press for assembly may result in forcing the parts out of truth. For this reason, it was decided to braze the main parts together, except for one joint, which only needs to be a light press fit.

The detail drawing shows a half-crankshaft component, which can be built up from a partly-machined disc and shaft, brazed together, and machined finished afterwards. Alternatively, it may be machined from the solid, or from a forging if available. Once upon a time it was possible to purchase rough drop forgings for gas engine valves, which were admirable for machining half-crankshafts, but I have not seen them for many years, as finished spare parts are now available for all engines, and repair shops rarely machine up new valves—or anything else for that matter. Incidentally, these forgings were usually in a pretty tough material, such as 3 per cent. nickle or a low nickel-chrome, which was a further advantage for the purpose we are discussing; but for the moderate duty for which this engine is primarily designed, a good quality mild-steel has been found satisfactory. If you decide to use a better quality material for the shaft journals, in order to make the engine suitable for higher performance, make certain that it has the right properties — toughness rather than brittleness, and resistance to surface wear. Some alloy steels are not easy to braze, except with special fluxes and this is an important point to watch if one is using a piece of



The other half-shaft set in position, without shifting angle plate, for turning the crankpin

unclassified bar, or scrap material of unknown origin.

The discs for the crank webs should be machined truly parallel on both faces, leaving not less than 1/32 in. for finishing, and a centre hole drilled $\frac{5}{16}$ in. diameter and well countersunk from the inner face. At the same setting, a circle is incised with a point tool at $\frac{9}{16}$ in. radius, a check being made across the diameter with divider points set to $1\frac{1}{8}$ in., in order to minimise possible error. While in the lathe, a line should be scribed across the face of the disc with a scribing block set to dead centre, to facilitate marking out the crankpin centre and balance weight.

Centre-punch the intersection of the circle and cross line to locate the crankpin centre, and scribe a circle $\frac{5}{16}$ in. diameter at this point, also marking a point each side of the centre at $\frac{5}{16}$ in. radius, at both ends of the cross centre line, and scribe parallel lines to mark the sides of the crank web. The full angle of the balance weight is 150 deg. (75 deg. each side of the cross line), but if means of accurate angular measurement are not available, this angle is not absolutely critical, though it should at least be symmetrical. A hacksaw may be used to cut away the unwanted parts of the disc, but first drill a $\frac{3}{16}$-in. hole at the intersection point of the web and balance weight, keeping outside the lines, so as to leave a radius at this point, avoiding a sharp internal angle which might possibly develop into a crack in the stresses set up by heating the disc for brazing or subsequent processes.

A hole not larger than 9/32 in. diameter may be drilled on the crankpin centre, using a small pilot drill to ensure true location. The discs may be bolted together for filing up the cut surfaces and a check on symmetry may be made by offering them up together in reverse after initial shaping. Open up and ream the hole to receive the crankpin in one of the discs only.

Turn up the shaft journals between centres, leaving them well oversize, except on the spigots which fit into the webs. These should be a moderately tight press fit, and may be finished by draw-filing longitudinally, or light parallel knurling, so as to produce score-marks in an axial direction to help the flow of the brazing metal. The crankpin may also be roughed out in the same way, but not drilled through the centre. Make certain that when pressed in, the shafts will go right home to the shoulder in the crank discs; a slight undercut is often specified in cases like this, but I prefer to chamfer the edge of the hole slightly, in order to avoid any possible risk of weakening the shaft. The ends of the spigots should also be chamfered, and the outer side of the hole in the web in which the pin is to be brazed should be countersunk; this will provide a well to hold the flux, and help lead the brazing metal into the joint.

Brazing

Before pressing the shafts and crankpin home, they should be well coated with paste flux; in the particular engine under discussion, Boron compo or "blue borax" was used, mixed with water to about the consistency of ordinary paint. There are several proprietary fluxes on the market, which will serve just as well, or possibly better; the only one of these which I can recommend from personal experience is "Tenacity" flux made by Messrs. Johnson Matthey of Hatton Garden, who are also the makers of "Easy-flo" silver solder, which was used in this particular case.

Incidentally, the term "brazing" is employed to cover all forms of hard soldering, whether silver solders or brazing spelters are used. One can use soft brass wire as brazing metal, if plenty of heat is available, but silver solder is easier to use and does not call for such high temperature, while its mechanical strength is quite adequate for this kind of work. A "penetrating" spelter—one which has a high fluidity when molten—is more suitable for a highly stressed mechanical joint than one of a more plastic nature, such as Sifbronze, which is more useful for external reinforcement of the joint by building up a fillet at the junction. In this case, where the parts are machined after brazing, the fillet would only be machined away.

The half-shaft, after assembly, should be set up vertically in a bed of coke or broken asbestos "coals," with the disc uppermost, and the "well" around the shaft spigot filled with paste flux. It is desirable to heat the metal as quickly as possible to minimise oxidation or scaling; a gas blowpipe or large blowlamp is advisable, but I have had successful results with a large Bunsen type "self-blowing" blowpipe. A pointed steel wire or broken hacksaw blade should be kept handy for scratching the joint to penetrate oxide and assist the flow of the metal. Do not attempt to apply the brazing strip until the flux melts and flows like molten glass, when a mere touch of the strip should be sufficient, and the fluid metal should "flash" into the joint. Most of the failures in brazing are caused by slow or inadequate heating, the spelter being only partly liquefied and becoming oxidised before it has a chance to penetrate the joint. If the metal "rolls up" into balls, apply a little more flux paste with the scratch wire and scratch the metal at the joint to break down surface tension.

When once the penetration of the joint is assured, allow the job to cool to a black heat, then turn it over, and in all probability there will be a ring of brazing metal showing on the other side as a witness that it has penetrated completely through the length of the joint. This is always a welcome sign, but if it does not appear, a little extra fluxing and re-heating on this side will enable more metal to be run into the joint. The crankpin may also be dealt with from this side, though a preliminary application of the brazing strip, at the same time as the main spigot is dealt with, is a good policy.

Machining the Crank Throw

After allowing the crankshaft components to cool naturally, the rest of the machining may be carried out. The centres in the main journals are first very carefully cleaned out, scraping out the flux and oxide with a file-tang, and then entering the centre drill just sufficient to show bright metal. Mount the shaft between centres and turn the main journal, not necessarily to finished diameter, but smooth and parallel, and uniform

diameter in the case of the two journals. The outer face of the web carrying the crankpin, and both faces of the other web, may be machined at this setting.

It is now necessary to provide a means of setting up the shaft on the crankpin centres to machine the crankpin on the web of one half, and the bore of the socket into which it fits, in the other. Several methods of eccentric mounting have been described in THE MODEL ENGINEER, all of which are satisfactory if properly applied; the method employed by Mr. Message in constructing the engine in question was to use a simple clamping fixture mounted on an angle plate, as shown in the photographs.

Two pieces of $\frac{1}{2}$-in × 2-in. mild-steel bar were used to make the clamp, and after cutting off two lengths of 2 in. and squaring up the ends, holes for the clamping bolts were drilled at $1\frac{1}{2}$ in. centres. It would have been desirable to space them closer together, but this was the minimum distance allowed by the slots in the angle plate used. The holes in the lower plate were tapped so that it could be secured to the angle plate, and would not move when the nuts were loosened to release the top plate, in which, of course, the holes were opened out to clearance size. Bolts having a sufficient length of thread to screw into the lower plate, and clamp it in position from the underside, were used.

The plates were first clamped together on the angle plate, with a piece of cardboard between them, and set up on the faceplate with the division line central; then faced, drilled and bored in this position to take the shaft journals a push fit. This is their condition as shown in the first photograph, except that the nuts have been removed from the bolts in preparation for lifting the top plate to remove the cardboard separators, so that the shaft journals could be clamped.

It was considered desirable first to operate on the bore of the hole of the timing end half-shaft, and after the latter had been mounted in the clamp, the angle plate was set over to locate this hole to run true, using a "Unique" test indicator to facilitate this operation. Note that this was done by setting the angle plate *towards* the centre rather than away from it, the object being to reduce the possible risk of spring, and also the moment of unbalanced weight, though, even so, this was fairly considerable, as the angle plate was pretty hefty, and this explains the use of the small angle plate and the collection of faceplate clamps bolted on the other side of the faceplate centre.

Having bored this hole truly and finished it with a $\frac{5}{16}$-in. reamer, the part was removed and replaced by the other journal incorporating the crankpin. Here the importance of machining the two shafts parallel and to exactly the same diameter will be appreciated, as any discrepancy in this respect would result in variation of the radial position of the crankpin and socket centres. The angle plate must on no account be moved when changing over the parts; the crankpin may be tapped sideways before tightening the clamp, in order to set it as truly as possible in this plane, but any radial error found to be present must be left as it is.

If desired, the end of the pin may be centred and the tailstock used to support it for turning, but great care must be taken to avoid springing it by end pressure, either when centre-drilling or when supported by the back-centre. It was considered better not to do this in the case illustrated, and no difficulty was experienced in turning the pin and facing the inner surface of the web. The end spigot was turned down and finished to a tight fit (about 0.0005 in. interference) in the socket of the other web, and the pin was then centred and drilled through $\frac{3}{16}$ in. diameter.

Final finishing of the crankpin journals, and the turning down of the ends, are carried out between centres, but it is advisable to leave the ends slightly oversize to allow of fitting the flywheel collet and the contact-breaker cam at a later stage. The use of ring laps to finish the main journals and the crankpin is advisable, and it is surprising how much inaccuracy will show up on what appears to be a perfectly turned and finished surface, when one applies the lap.

(To be continued)

Removable Boiler Flues

(Continued from page 793)

ufacturers' catalogue, shows the whole contraption in great detail. We can fully endorse Mr. Messer's remarks! But, to be fair, we feel that we should quote a few sentences which are printed below the illustration in the catalogue; they read: "For some countries where the water is specially bad, we have designed the above type of engine. By unscrewing the nuts on the frontplate, and those fastening the tubeplate to the smokebox, the whole of the interior of the boiler can be drawn out to be thoroughly cleaned, as shown by the above illustration. Owing to various causes which make this boiler a less favourable steam producer than the locomotive form, we recommend the latter in all cases where it can be adopted."

The last two sentences quoted are especially interesting and contain a great deal of food for thought. Moreover, we wonder whether anybody has ever tried to reproduce one of these "removable-flue" boilers in miniature! We should imagine that nothing but scale-size studs, stays and nuts could be used without spoiling the look of the thing; and if the miniature were intended to be a *working* proposition, we should think that it is long odds that the builder would soon discover the truth of the idea about Nature refusing to be scaled!

"Golden Arrow"

A Christmas Ghost Story

by "L.B.S.C."

IT was the first week in January, 1981. The railways of Britain had reverted to company operation some 20 years or so before, and the directors of the new Southern Railway were holding their annual meeting in the big board-room at the Cannon Street Hotel. At this meeting, the events of the past year were reviewed, accounts examined, alterations and improvements in tracks and rolling-stock discussed, and plans made for the future. The chairman, Sir John Brummy was speaking.

"Well, gentlemen, you have heard from our Secretary that we have had a very good time during the past year, and are well on the way to prosperity. The lowering of freight rates has seen a marked increase in our goods traffic, and the introduction of cheaper fares, ordinary, season, and excursion, has filled our passenger trains to capacity. Every train run, has shown a small profit; and as our Scots friend farther down the table would say, 'mony a mickle maks a muckle.' I don't need to remind you that every member of this board is a real live wire, taking full-time interest in some department of our railway. My own, as you know, is the steam locomotive department." ('Live wire on a steam locomotive,' says Pat,' interjected the Chief Electrical Engineer with a broad grin. Sir John joined heartily in the burst of laughter which followed.) "Mr. Watts certainly caught me there, he is as quick as his own juice! However, you have also heard Lord Iron's report on the permanent way. Whilst relaying the electrically-operated routes with 150 lb. flat-bottomed rails on reinforced concrete sleepers, our civil engineering department decided that it would be good policy to give the steam routes similar treatment, and do some realigning as well; and as Lord Iron told you, the last section was finished some six weeks ago. Our underline bridges have all been strengthened, and all sharp curves at main junctions have been eased out; so that a speed of 70 miles per hour can be maintained through such places as the Bickley loops, and Mitcham Junction.

"Our Chief Mechanical Engineer figured in the New Year's Honours list, and like his illustrious predecessors on the old L.M.S. and L.N.E.R. lines of bygone days, Sir William Stanier and Sir Nigel Gresley, he was awarded a knighthood for his research work and improvements in locomotive design. I have been in consultation with him about speeding up our steam train services, starting with the 'Golden Arrow,' to run from Victoria to Dover Marine in the level hour. He says it can be done. Now, Sir Roy, let's hear from you."

Sir John sat down, and Sir Roy Donalot, the Chief Mechanical Engineer, rose to his feet with an air of a schoolboy being "found out," rather than an eminent locomotive engineer whose abilities were so well known and recognised. After a few seconds' hesitation, he said: "Gentlemen of the Board, it has always been my aim to have on the Southern metals, the finest stud of steam locomotives it is possible to build. As you know, we had a rough old lot when I was first appointed; but by scrapping the worst, and doing drastic rebuilding, and then later putting new designs on the road, we are now able to run our trains, not only to time, but at low fuel and maintenance costs. By giving each of our drivers an engine of his own, and encouraging him to take a pride in it, also by introducing the old coal premium system again, we have the maximum of efficiency at the minimum of expenditure. But there is just one point that has got under my skin, so to speak. The record set up by the old L.N.E.R. engine *Mallard*, of 126 m.p.h. has, so far, not been beaten. Our friends of the Great Western, North Western, Caledonian, etc., often touch two miles per minute on favourable stretches; and we have done it on our own line between Basingstoke and Surbiton, very often. I wanted to break that record; and in my little workshop at home, have built a small locomotive which embodies some improvements in boiler and valve-gear. I have brought it to show you; and if you will vote the necessary sum to build a full-sized edition, I think I can promise you that 'Southern for Speed' will be our new slogan, and we will not only be able to run the 'Golden Arrow' in the hour, but smash *Mallard's* record, and any other that our good neighbours may put up."

Two porters had meanwhile carried a long packing-case into the board room, and removing the lid, lifted out the little engine and placed it on the table. It was a lovely job, and the directors crowded around to examine it. Sir Roy explained the improvements he had made, and gave his estimate of the cost of building the full-sized one; and when Sir John asked if the big engine could be built and thoroughly tried out, in time for the summer services, Sir Roy said yes. The works at Ashford, where the Eastern section engines were all built, were keen to "have a bash," as they said, in friendly rivalry with the other works at Brighton and Eastleigh; and the staff would guarantee to have the new engine ready to haul the "Golden Arrow" on the advertised day. The directors unanimously voted that Sir Roy should be empowered to spend all he needed on the job; and wishing him good luck, Sir John declared the meeting closed.

Sir Roy returned to Ashford, where he lived, and next morning took the little engine to the works. He explained to the drawing-office staff exactly what was needed, and then called a meeting of all the foremen and charge-hands, telling them what had transpired at Cannon Street the previous day. The whole staff, right

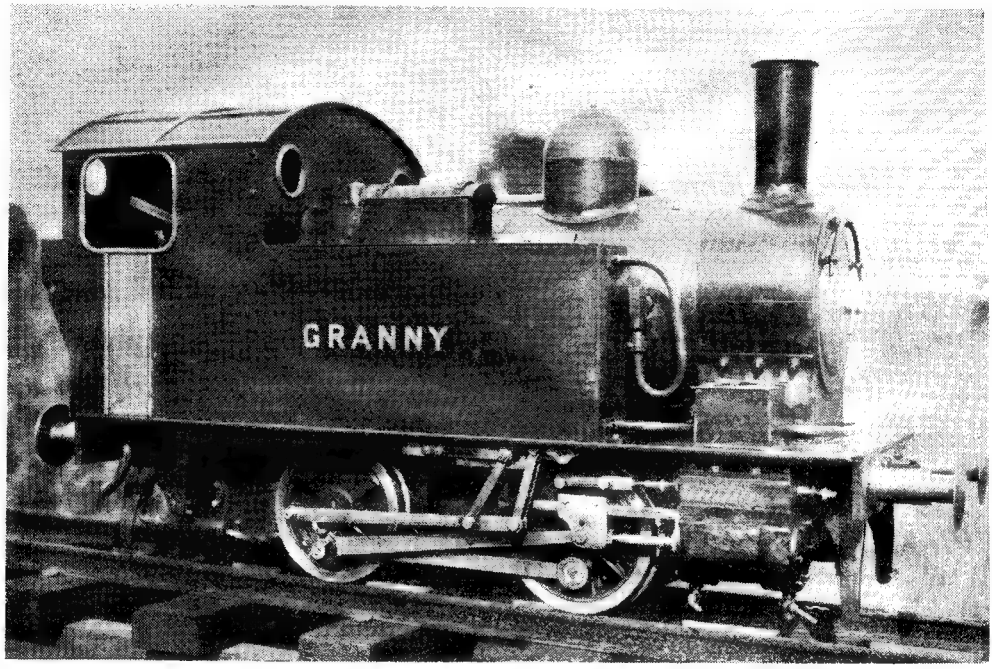


Photo by] *Mr. Carl Purinton's version of "Juliet"* *[A. C. Milburn*

from Works Manager down to the newest apprentice, became filled with enthusiasm, not only for Sir Roy's design, but with the idea of taking a friendly "mike" out of Brighton and Eastleigh, and literally "pulling a fast one" on their Great Western neighbours, with whom they were in friendly competition on the West of England lines. Ere a week had passed, the whole of the drawings had been made, material ordered, and the pattern shop was working overtime on the patterns for the cylinder castings and other important parts.

Building the Record-breaker

Sir Roy had taken for the basis of his design, the Pacific type engine which was designed by a previous C.M.E., Mr. Maunsell, but had never been built because it would have been too heavy for the track and bridges, as they were at that time; but now, with the bridges and heavy permanent way capable of sustaining a 30-ton axle load, there were no restrictions. Up went a pair of 1¼-in. plate frames, with a trailing cradle, and drag and buffer beams to suit. A new type of welding had been introduced, eliminating entirely the former risk of flawed joints, and full use was made of this in the frame construction, especially in the cross-staying. The leading bogie was similar to that on the old "Lord Nelsons," with independently-sprung axleboxes, which had proved most satisfactory for high speed; but the axleboxes had roller bearings, and Sir Roy's own centring device, which ensured absence of "nosing" or "shouldering." Huge roller bearings were fitted to the coupled-wheel axleboxes, and ordinary outside roller-bearing axleboxes were provided on the trailing pony truck. This had a fabricated steel frame, of a special design which allowed for a hopper ashpan, with dampers and dumping gear. The cylinders arrived in the erecting shop just as the frames were finished; there were three of them, 23 in. bore by 28 in. stroke. The overhead crane got busy, and they were soon installed; the outside pair between the bogie wheels, and the inside one right up ahead, so that it could drive the leading axle, which was cranked. At this stage, a variation in erecting was made. The wheels were usually run under the frame after the boiler had been put on; but as Sir Roy wanted to see how the motion and other components fitted in, he gave instructions to erect the chassis as near as possible complete before dropping the boiler in place, and this was done. The six-coupled wheels were 6 ft. 3 in. diameter; they were spoked, the centres being of a tough alloy steel, but the spokes were of a special section which eliminated any risk of cracking. The tyres were 3 in. thick, with treads almost cylindrical, and "ice-cutter" flanges. The coupling- and connecting-rods were light and "spidery," being

made from special high-tensile steel first used on the London & North Western 4-6-4s and the Caledonian 4-6-2s which, as we already know, were performing prodigious feats of sustained high speed with 18-coach trains on the lines mentioned. Roller-bearings were fitted throughout.

The valve-gear was Sir Roy's " ace of trumps." The three sets were made up on the unit-construction principle. The two outside sets were similar to Baker gear, eliminating sliding die-blocks in slotted links ; and the inside set was the final development of the Holcroft gear for three-cylinder engines, consisting of a small triangular frame attached to the inside motion-plate, containing three small levers only, with ball-bearing pins. The valve-rods worked on to a combination lever, same as on the outside gears ; this was necessary, because each cylinder had two piston-valves, a medium-sized one for admission, and a big one for exhaust. By an ingenious arrangement worked off the tops of the combination levers, not only the admission point, but the release point, could be adjusted, to suit the speed of the engine. The actual adjustment was done by three small servo-motors, controlled by a miniature wheel-and-screw reverser in the cab. This had two hand wheels ; one about 8 in. diameter, mounted on a sleeve, and another 4 in. diameter, mounted on a spindle working inside the sleeve, so that the wheels were concentric. Every joint in all three sets of gear, had either a ball- or roller-bearing, enclosed and lubricated with soft grease.

In the high-speed trials of the late 1930s, trouble in galore had been experienced through the big-ends of the inside cylinders on three-cylinder locomotives, overheating and running the metal. Sir Roy had got over this by using a novel type of roller-bearing big-end ; the crankpin itself, formed the inner race, being hardened and precision-ground, and the other race took the place of the usual brasses. The joint was serrated, giving a continuous surface for the rollers to run on. The whole issue was secured by two clamp blocks with bolts, the complete assembly bearing a strong resemblance to a Stroudley big-end on the old Brighton engines of a century previous.

Meantime, the boiler shop hadn't been idle. The boiler had a 20-ft. barrel, 6 ft. diameter at the smokebox end, and 6 ft. 6 in. at the firebox, which was of the Belpaire type, modified similarly to the Pennsylvania engines in U.S.A., and 10 ft. long. It had a long combustion chamber, with Sir Roy's own type of syphon tubes, and the barrel was nearly all superheater flues, each containing a four-unit element. The smokebox front was shaped like a shell nose ; the wide chimney had a variation of the Lemaitre five-jet blastpipe, which had instead a large number of small jets giving the effect of the rose of a garden watering-can. The chimney was just wide enough to match the 6-ft. smokebox shell, and was of the stovepipe pattern, very short, merely a ring and base, on account of the limited load gauge on the Eastern section. For the same reason, the dome was very squat, and the four safety-valves, set to blow at 260 lb., were arranged horizontally, " sprouting " from a low turret on the wrapper. The deep-toned chime whistle was also horizontal. The backhead fittings were standard Southern pattern ; reflex water-gauges were installed, a pneumatic firehole door, and, of course, a mechanical stoker.

The boiler was soon erected and connected up ; then came the upper works. The running-boards were placed just above the wheels, eliminating any need of splashers, the front part being upswept from the buffer beam in a graceful curve. The rear part was also curved up, to join the sloping and rounded part of the cab, the sides of which were " pure Maunsell." Details included the Westinghouse quick-acting air brake, with electrical control, to ensure simultaneous application on every vehicle in the train ; two exhaust injectors, and a live-steam ditto ; and electric lighting, from a small turbo-generator by the footstep on the driver's side. Automatic train-control on the G.W. system was fitted ; and a two-way radio-telephone, with loud speaker, provided communication between driver, passengers and guard. The tender ran on two four-wheeled bogies, and had a water pick-up scoop for use on the Western section, where troughs had been installed. The capacity was ample for any run on the Eastern or Central sections, although it was unlikely that the engine would ever invade the domain ruled by Queen Milly Amp.

The Engine Takes the Road

The engine was finally completed by the end of April, and everybody in Ashford works was all agog to see what she could do ; so Sir Roy gave all the staff a treat. She was steamed up, and given three or four preliminary runs as far as Tonbridge and back, to see that everything was O.K., and then Sir Roy had a train of coaches made up to the weight of the " Golden Arrow " and invited the staff to ride on it up to London and back, early on a Sunday morning, when there were no goods trains around, and the passenger service had not started. The staff turned out *en masse*, and the train was crowded ; a dining car had been included, so that tea and a snack were available for all who fancied it. With Sir Roy himself at the regulator, the engine yanked the train out of Ashford station, accelerating up to 75 m.p.h. exactly as if a powerful electric locomotive were hauling it. The reason for this, was Sir Roy's patent accelerator-control valves. Sir Roy, although a brilliant steam locomotive designer, was not interested in electric traction, and had made no study of the working conditions of an electric motor ; but the Chief Electrical Engineer, Mr. Watts, was a great friend of his, and had explained that if Sir Roy's engine could maintain the push on the pistons as the speed increased, he would get the same effect as the sustained pull on the armatures of the electric motors, as the resistances were cut out. Sir Roy promptly designed an automatic valve that acted as a sort of " steam resistance," allowing a constant pressure on the pistons right up to the cut-off point, although they were, in a manner of speaking, " running away from the steam " as the engine accelerated.

Though new, the engine ran perfectly free, on account of the ball- and roller-bearings ; but

Sir Roy did not let her out on the run to London, though the way she sustained a steady eighty up the long bank through Hildenborough, was a foretaste of things to come. The train took the "Golden Arrow" route via the Bickley loop, and ran into the Brighton side of Victoria Station, where the long platforms enabled the engine to run around the train, and get to the turntable, before coupling-on for the return trip. The staff got out and stretched their legs, and a few "early birds" came along and looked at the new engine with interest. Sir Roy quietly passed the word around to "sit back and hold tight" after Tonbridge; because, if the engine behaved herself, he would let her go, and see if she could beat *Mallard's* speed between that place and Ashford. On restarting, the sustained acceleration up the 1 in 64 to Grosvenor Road bridge, proved that Sir Roy's acceleration valves were "doing their stuff." Speed was not allowed to rise above 70 till the Bickley loop was passed, but the distance between there and Tonbridge was covered in record time, and when Sir Roy finally let her out, the fur began to fly in deadly earnest! Up went the speedometer needle, past the 100, then two miles were covered in a level minute, to the great delight of the staff, who had plenty of watches out; finally the coveted 126 was reached and just passed, after which Sir Roy shut off, and quietly coasted into Ashford station. The engine came off, and ran to the sheds, where Sir Roy, the driver and fireman, and the running-shed foreman throughly examined her. She was in perfect condition, as cool as a cucumber; and the coal consumption came out at a little under 40 lb. per mile.

On the Monday morning, Sir Roy took his report to the spring meeting of the Board of Directors, and told them to go right ahead with the hour schedule for the "Golden Arrow." Sir John and his colleagues offered their hearty congratulations; and when Lord Iron proposed to name the engine after Sir Roy's wife, Lady Vera, it was carried unanimously, with much acclamation. It was also arranged to invite Sir Roy's daughter, Joy, to perform the naming ceremony 15 minutes before the start of the inaugural run on the one-hour timing; and the whole Board of Directors, with representatives of the Press, and engineering institutions, would accompany the train, Lady Vera herself being the guest of honour in the dining car. Joy had previously served the company in the offices; and had fallen in love with, and married, her departmental chief. That worthy often said he lost a first-class secretary, but gained a first-class wife, adding "I was boss then, and Joy took orders from me—but now she's boss, and I have to take orders from her!" Joy was in her late thirties, a fine woman with a keen sense of humour, and had two beautiful daughters, Rosa and Joyette.

The Great Day Arrives

The summer timetables were due to come into force at the end of May; and there was great excitement at Victoria Station when a shunting engine pushed the brand-new string of twelve Pullman cars forming the "Golden Arrow," into the departure platform. They were built with aluminium-panelled bodies on light alloy underframes, and were air-conditioned; they also ran on roller bearings. Such a fine train had never been seen since the advent of the first "Southern Belle." They were finished in the familiar Pullman "chocolate cream" and each had a long golden arrow at the edge of the cornice above the windows, matching the gold lining to perfection. Passengers and guests began to congregate on the platform; Sir John, Lord Iron, and the general manager all came together, then Lady Vera, Joy and her daughters; directors, Pressmen with cameras, officials of the other railways who had been invited, and some eminent personalities from other branches of the engineering world—a merry crowd indeed.

There was a gasp of admiration as Sir Roy's masterpiece, in charge of Driver Ralph Coney and Fireman Pete Piper, quietly slid into the platform road and backed on to the train. When the automatic coupler clicked, Pete jumped down, coupled up the brake pipes and the electrical control jumper, and gave Ralph the signal for his brake test, which was promptly made. As the engine stood there, with the Westinghouse pump busy restoring the air pressure, she seemed more like a living being, pulsating with energy, than a piece of machinery created by mankind. The paint-shop at Ashford works had "done themselves proud," finishing off the engine in a manner really worthy of her; the flawless shining green coat was lined black and gold, and the handrails, buffer-heads, cylinder covers and other parts were chromium-plated. The new Southern crest, embodying the coats-of-arms of the principal cities served by the company, adorned the centre of the tender side, with "Southern Railway" in a garter around it. Sir John had remarked, in his opening speech when appointed chairman, that smart clean engines and carriages would attract the passengers; and he had been proved absolutely correct, as traffic had shown.

The "Hon. Joy," as her dad now fondly called her, climbed on to the running-board, and the crowd gathered around. "Ladies and gentlemen," she said with a smile, "I'm no good at making long speeches; and anyway, it is too close to leaving time, so I'll just tell you how very much we all appreciate the honour of seeing mum's name on this engine. As a locomotive engineer's daughter, I should recognise a good engine when I see one; here we have a real peach—smart, graceful and very fast. She's like dear old mum in being smart and graceful"—here Lady Vera dropped a curtsey—"but I wouldn't go so far as to say mum was fast." (Loud laughter, in which Lady Vera joined.) "May the engine always uphold the honour and traditions of the Southern Railway; it gives me great pleasure to name her *Lady Vera*." There was loud applause and clicking of cameras, Joy pulled off the strip of cloth and displayed the chromium-plated name plate on the side of the boiler.

Hardly had the applause died down, when there was another burst of cheering, clapping, and laughter. The fireman had stepped down from the footplate and was standing beside the cab, when 13-year-old Rosa, who looked quite 18, quietly slipped her arm through his, and the

pair of them were posing before half-a-dozen Press cameras. A splendid picture they made, too; Rosa's dark curls and pink dress made a perfect colour blend with the fireman's fair hair and light blue overalls. Five-year-old Joyette had climbed on to the footplate, and the driver had picked her up and was holding her shoulder-high, whereupon the young lady promptly flung her arms around his neck and gave him a hearty kiss, which he, nothing loth, had just promptly returned!

"The 'Golden Arrow' Continental Express will leave in three minutes; take your seats, please!" A pleasant voice from the loud-speakers above the platform, gave this reminder, and passengers and guests loaded up into the Pullman cars. Sir John escorted Lady Vera, Joy and the girls into the dining car, as Sir Roy was travelling on the engine. Pete started the mechanical stoker, and opened the blower-valve a shade. The last bit of baggage was put in the van, folk on the platform stood back from the train, Pullman attendants passed their "all-ready" signal down the line of cars, and the guard waved his flag. "Whoo!" remarked *Lady Vera* Pete gave the whistle-cord a tug, and Ralph slowly opened his regulator. The race against time was on!

Lady Vera gave a deep sigh and a quiver she took the strain, and then "whuff-whuff-whuff! whuff-whuff-whuff!" came in sharp staccato barks from her squat chimney she dived under Eccleston Bridge and started to climb the bank. Sir Roy's accelerator valves immediately came into action and maintained the full pressure on each of the three great piston-heads, keeping the sustained tractive effort right up to the limit of adhesion; the acceleration was amazing. An electric express bound for Brighton, had snaked out of the other side of the terminal, and the two trains had come together on the rise up to the river bridge, but *Lady Vera* was more than holding her own, and actually reached the summit ahead of the electric train, despite the latter's four motor coaches in a train of the same length. Ralph adjusted his twin cut-offs, admission and exhaust, and opened the regulator halfway, whilst Pete started the exhaust injector, and adjusted his mechanical stoker valve for a steady feed. Up went the speedometer needle, 70 at Factory Junction, 80 at Brixton, and *Lady Vera* "whooed" as she swept around the curve, clattered over the crossings, and dashed past the sightseers on the platforms at Herne Hill. She added another 5 m.p.h. up the long rise past West Dulwich, and with another defiant "whoo!" dived into Penge Tunnel, and went through it like a bullet through a gun-barrel. The 100 went up, down the slight descent to Kent House, and this was sustained up the rise through Bromley and Bickley, where more people had congregated on the platforms to see the record-breaker's inaugural run. Here Driver Ralph shut the regulator, and made a slight brake application, bringing speed down to 70 again for the Bickley loop. As the engine swung into the old S.E. & C.R. main line at Petts Wood Junction Sir Roy called into the loud-speaking telephone "Diner ahoy! How is she riding?" "Fine!" came back the voice of Lady Vera. "We haven't upset a thing yet!" Ralph set his valve-gear wheels once more, and this time he pulled the regulator wide open. The stoker engine under the footplate steadily clanking away, the exhaust injector humming, and the steam gauge needle seemed a fixture on the 260 lb. mark, an occasional spasmodic pop from one of the safety-valves indicating that the pressure was there all right. Now things began to hum in earnest. The 100 went up again at Orpington, and this was easily held up the bank, past Chelsfield and Knockholt, to Polhill Tunnel; and it was at this point that *Lady Vera* decided to gather up her skirt and thoroughly enjoy herself in the manner usually observed among well-bred pedigree express locomotives. She shot out ot the south end of the tunnel, the string of Pullmans trailing after her like the tail of a kite, though running as steady as a bird on the wing, due to the compensated springing, dashpot shock absorbers, and the perfect alignment of the girder-like 150 lb. rails. She tore through Dunton Green at two miles per minute, rushed the rise to Sevenoaks, and "whooed" again in joyous abandon ere she plunged into the long tunnel. Out again into the spring sunshine, she passed *Mallard's* record at Knockholt, the station seeming no longer than a signal-box to the three men on the footplate. Then, behaving like the perfect lady, she slackened her mad rush, as Ralph shut the regulator, and eased down to 70 as she swept around the long curve at Tonbridge Junction, greeting the spectators on the platform with another "whoo-oo," which is "enginese" for "Here we come, mum!"

As soon as the last car had cleared the station, Ralph pulled the regulator wide open again. *Lady Vera*, now suffering from a bad attack of speeditis, immediately began to accelerate rapidly up the rise beyond the junction; and then a strange thing happened. As Ralph went to adjust the cut-offs once more, he paused, stared in amazement, touched Sir Roy's arm, and pointed. *The two handwheels were moving, apparently of their own accord!* "What's happening, Sir Roy?" he asked. Sir Roy smiled. "She's only trying to set herself in the best running position," he replied. "Some of the old engines used to do it. Drivers always said the Webb compounds would go better if you let them find their own position of the cranks. Anyway, let her be, and we'll see what she does." Speed was over the 100 again as the topped the rise; then the handwheels moved again, first together, then separately in opposite directions, and finally the inner one, which controlled the exhaust point, moved slowly, then came to rest *Lady Vera* began to accelerate faster than she had hitherto done on the whole journey thus far. Up went the speedometer needle as she raced down the grade—120-125-130-135-140—"Migosh," ejaculated Ralph, "she's got hold of 'em now!"—143-146-148-149-150! At two-and-a-half-miles per minute, she flew through Paddock Wood.

"What about the old spam-cans now, Roy?"

All three men on the footplate heard the words, spoken softly and distinctly. Sir Roy glanced at the telephone speaker, and said "Lady Vera, one of her friends, is doing a bit of leg-pulling." "It didn't seem to me, to come from the loud-speaker at all," rejoined the driver, "but there

nowhere else it *could* have come from, unless my mate is a ventriloquist." "Not guilty!" said Pete. "It was somebody in the train, right enough." So no more was said about it; but the exhaust control wheel did not move again, although the admission one did, on the slight undulations of the line between Marden and the signal-box at Great Chart. Speed never dropped below 140 miles per hour, the filmy exhaust blowing along the top of the boiler and streaming away over each corner of the Belpaire firebox, giving a clear view ahead. As the 150 mark was again touched on the slight fall towards Ashford Station, Sir Roy winked at the young fireman, and said "Go ahead, Pete, tell your girl friend we're coming." Pete reached for the whistle cord on his side, then "Whoooo—whoooo—whoo-whoo!" came the voice of *Lady Vera*. Pete let go of the whistle cord as if it had been a live wire, and gasped "That was the American level-crossing signal. I'll swear I never blew it—it seemed as though somebody had got hold of the other cord!" "The engine swayed as we ran through the crossing; that's what did it—don't get scared," said the driver; and they tore through Ashford Station like a streak of greased lightning.

Meanwhile, the staff at the locomotive works had decorated Ashford Station with flags and streamers, and turned out in full force to see their handiwork go by. As the time drew near, watches came out. "She should be at Marden now"—"No, nearer than that—listen!" Heads were craned and ears cocked for the distant rumble—"She's passing Great Chart"—whooo—whoo—whoo whoo! A loud shout of "Look out, boys, here she comes"! and WHIZZ! The great green-and-silver engine shot under the bridge like a bullet; there was a confused blur of chocolate-cream Pullman cars, a terrific rattle and clatter as the flying wheels hit the crossing frogs, a cloud of ballast dust and bits of paper—"This is the 'Golden Arrow'—that was"—and the train dwindled to a speck in the distance. The flags and bunting that had been close to the edge of the platform awning were now just tattered shreds. A Cockney fitter's mate remarked "'Golden Arrer'—blimey, chocolate-cream doodlebug 'd be a better nime for 'er!" and called for "Free cheers for Sir Roy," which were heartily given.

On the footplate, the admission wheel moved slightly again, and the speed did not fall below 135 right up to the summit at Westenhanger. Sir Roy looked at his watch. "Ease her off now, Ralph; we're six minutes ahead of schedule!" The driver shut the regulator and let her coast, and the speed gradually dropped to 70, the roller-bearing cars coasting freely down the long incline which extended right to Dover. Pete shut off the stoker engine, and the fire died down to a dull red. After passing through the cliff tunnels, speed was further reduced, and finally the train snaked slowly around the last curve and came to rest at Dover Marine, exactly 58 minutes after leaving Victoria, 77 miles away.

The Lord Warden, all the local bigwigs, and a crowd of sightseers, plus the Corporation band, were all on the platform to welcome the train; and there were hearty congratulations on the enterprise of the Southern Railway, and the good folk responsible for the magnificent performance. When all the excitement had died down, the passengers transferred to the steamer, and the Board of Directors had adjourned to the hotel, Sir Roy said he could do with a spot of lunch; and as the family walked up the platform, he asked Lady Vera how the cars rode at the high speed. "Splendid," she replied. "If it hadn't been for the speedometer you had put in, for Sir John and the directors to see how fast we were going, I'd never have believed we were doing 2½ miles per minute at Paddock Wood. I thought at the time, there's only one thing missing; our old friend Curly should have been driving the engine—wouldn't it have been fine?"

Sir Roy gave a violent start, as a light broke in on his mind. "So *that* was it," he muttered; "I might have recognised the voice." He turned to his wife, and said, "My dear, Curly *was* with us. The spirit of our old friend drove the engine from Tonbridge to Sandling Tunnel, and blew the American level-crossing signal at Ashford; and it was Curly's voice that said "What about the old spam cans now, Roy?"

Invitation from Sweden

"TEKNIK FOR ALLA," the famous Swedish model paper is to organise an International Exhibition at Stockholm in March, 1950, where they hope to have a strong British entry of models.

Model engineers are invited by the organisers of the Swedish exhibition to submit information of their models to Mr. E. D. Stogdon, c/o Percival Marshall & Co. Ltd., 23, Great Queen Street, W.C.2, who is arranging the collection and shipment of the models. The cost of transport and insurance of the first fifteen models will be covered by "Teknik for Alla," the remainder by Percival Marshall & Co.

Models should be truly representative of this country and a full description giving overall dimensions, weight, value, etc., accompanied by a photograph should be sent to Mr. Stogdon as soon as possible and not later than *January 5th*, 1950.

A selection committee will then decide which models will eventually represent Great Britain.

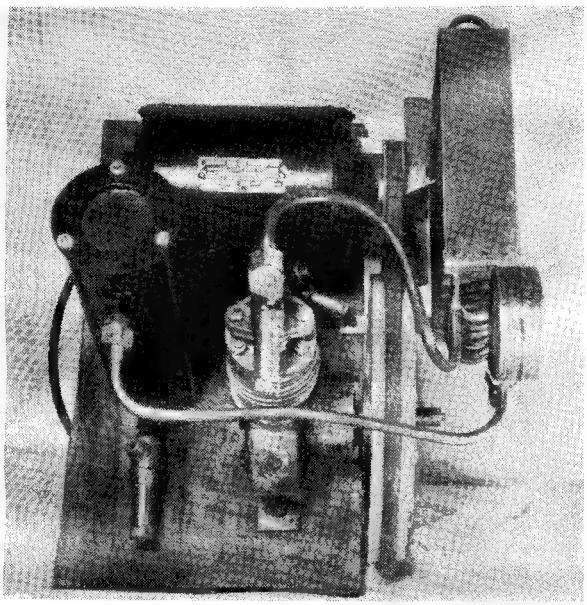
Many will remember how we enjoyed seeing models from Sweden in the 1948 MODEL ENGINEER Exhibition and we feel that this pleasure should be returned to our Swedish friends.

*A Domestic Refrigerator

by L. C. Sherrell

THE compressor is run at a speed of 500 r.p.m. A 10-in. flywheel with groove for ½-in. V-belt ("Dick" V-rope, No. 3A8) is keyed to the crankshaft by the usual tapered key, and if fitted properly, that is, top and bottom, there will be no need to drive in excessively, and it certainly will not require a set-screw and washer in the end of the shaft to retain it. Allow enough room behind the head to enable it to be withdrawn with a spanner at any time should it be necessary. The weight of this flywheel should be in the region of 9 to 10 lb.

A 1/6-h.p. motor, 1,425 r.p.m., is the motor best suited for the job, provided it has a high starting torque, as it must always start under full load; the load will fall off as the running time nears its end.



The condensing unit

Everything is now ready to be set out on the baseboard, the holes marked out and drilled. Make the bolts a tight fit in the wood so they don't fall through if anything has to be removed when completed. Some motors have rubber shock-absorbers fitted, if yours hasn't, it will be advisable to mount it on rubber strips.

The cooler is fitted just in front of the fan and held in position by two brackets screwed to the top of the baseboard; put the belt on first to make sure it will not foul these brackets. The ⅜-in. pipes can now be flared, sleeved and silver-soldered to the cooler, and coupled up to the discharge shut-off valve and the top of the liquid container respectively. Don't forget the four sponge-rubber blocks at each corner of the baseboard.

The Evaporator. Fig. 12

The temperature considered most useful in a domestic refrigerator cabinet is approximately 40 deg. F. To maintain this as economically as possible, the area of the evaporator in relation to the size of cabinet, bore and stroke of compressor, not forgetting the speed plus the area of cooler, must all be taken into account. It will be noticed that this evaporator is quite different from the one described by Mr. Meyland Smith, and which, to my regret, I first made, only to find it inefficient when used in conjunction with and expansion-valve. This expansion-valve, by the way, consists of a needle-valve operating in connection with a copper bellows or in some cases a diaphragm. On the other side we have the gas pressure, whilst the other is counterbalanced by a spiral spring, which by turning an adjusting screw clockwise will increase the tension on the spring and likewise the pressure in the evaporator, and vice versa. The action of this valve is very rapid, so that when the compressor is withdrawing the gas at a steady rate, this valve should be set to allow a pressure of 8 lb. per sq. in. in the evaporator which will give a temperature of 10 deg. F., or 30 deg. F. below the cabinet temperature. As this is below atmospheric pressure, and being a partial vacuum, it is measured in inches of mercury, when SO^2 is used as a refrigerant.

Now what happens with Mr. Meyland Smith's evaporator is this: The gas takes the easiest and quickest way out, which is up the first few pipes, leaving the remainder unfrosted. I mention this, as some constructors may have had the same trouble. This evaporator was duly scrapped and a new one made having a continuous coil, and what a great improvement, it was completely frosted within 15 min. of being installed, quite apart from this, it is far easier to make.

A wooden former will be required 10 in. long × 6¾ in. × 6 in. made from 1 in. thick boards, and nailed together—no ends are required. The corners are rounded to 1 in. radius. A piece of thin string around will give the length of

*Continued from page 764, "M.E.," December 15, 1949.

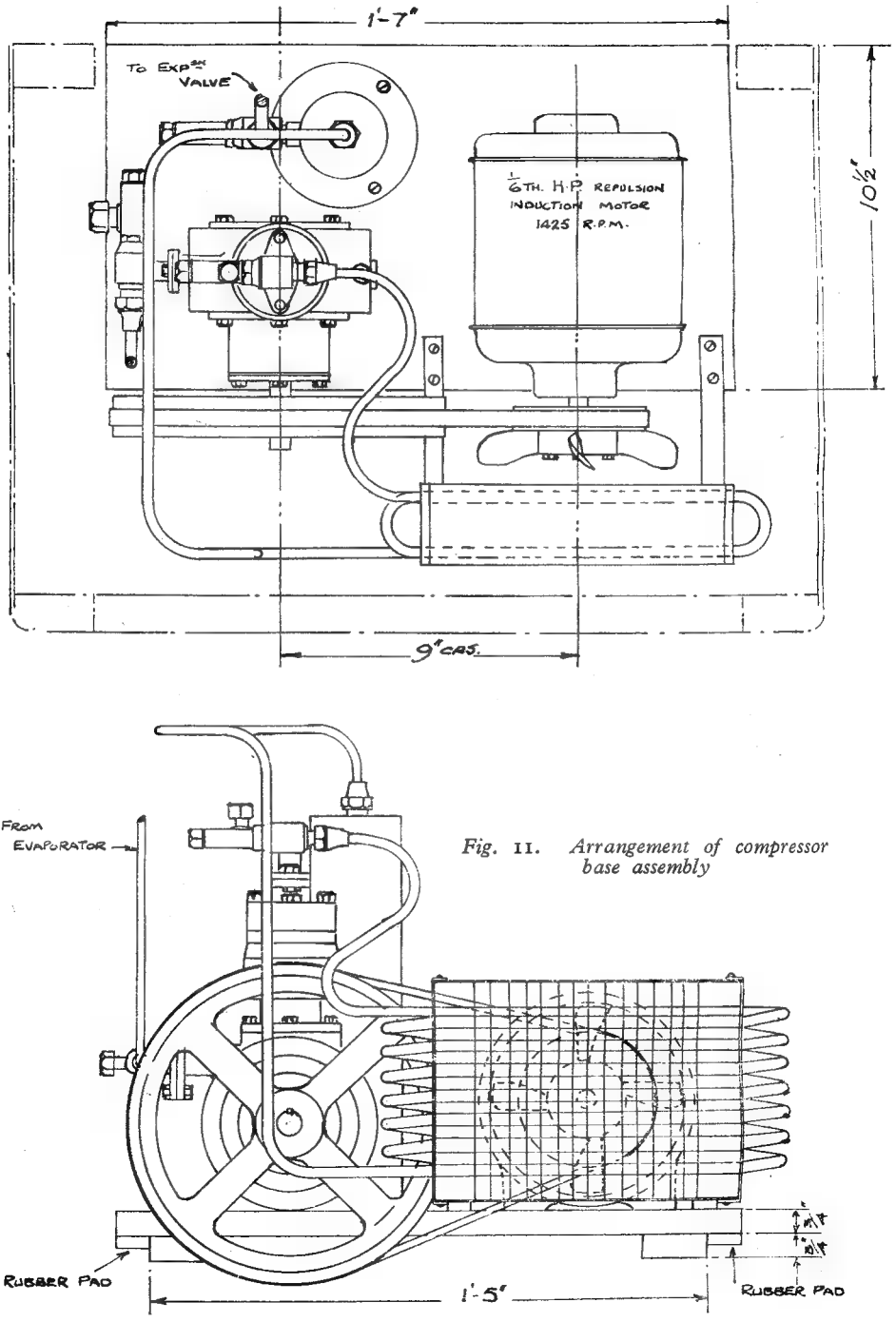


Fig. 11. *Arrangement of compressor base assembly*

*TWIN SISTERS

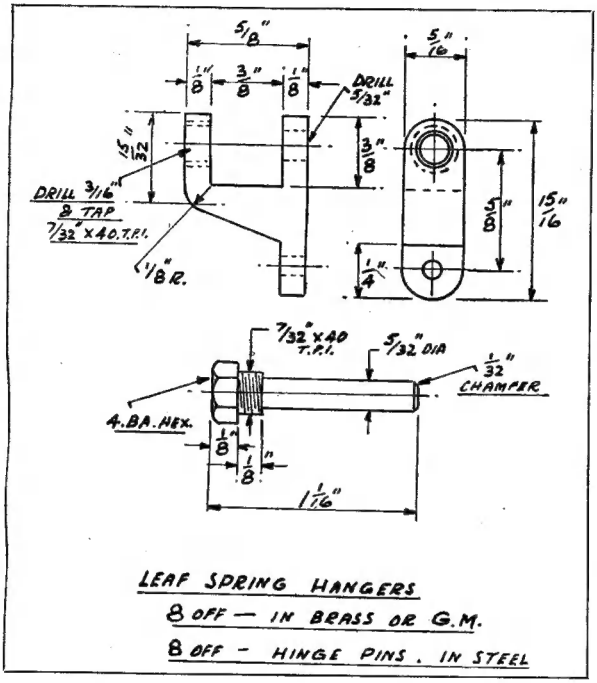
by J. I. Austen-Walton

Two 5-in gauge locomotives, exactly alike externally, but very different internally

THROUGH careful sorting and wangling, we should now be in correct step with the drawing part of the series once more, and we can go right ahead with the full description of the springing system as promised. This has been divided into two complete sections, the first section being devoted to the leaf springs used on the leading and driving axles, and in this case, all four are the same.

I did give you some little advance information on your material needs, in this case, extruded brass bar or a cast gunmetal stick for making up the eight spring hangers. Reference to the drawing will show how these parts lend themselves to "mass generation" in section on a milling machine, so that the formed bar may be sliced up into eight equal sections, needing very little after treatment to bring them to the finished-article stage. They could, of course, be milled on the lathe by means of an end-mill, with the short bar held in the toolpost, or on a vertical slide. This is an ideal case, also, for the small bench planer with its usually very limited stroke, but such a machine would make very short work of the hangers, including the rounded cheek under the projecting limb. For such a very short bar, a file would probably do the same work in less time than it takes to set the job up on a machine. Notice that the hinge-pin that goes into the bracket, has its thread under the head and not on its far side. The idea is to permit of the tightening of the pin without fear of collapsing the bracket, which, in other respects is amply strong.

Returning to the brackets themselves, I advise you to mark out the bar after the section has been machined, leaving a clear $\frac{1}{16}$ in. double line between each bracket, for sawing off. Mark out all the holes, drill and tap where shown, remove all burrs, and then separate the items. There is very little file work left, and the resulting parts will be clean and quite uniform.



The heads of the hinge-pins are shown as 4-B.A. but could to advantage be smaller. If you contemplate shaping up the heads separately, it is no more trouble to put 6-B.A. heads on these, but it would mean leaving a narrow turned collar between the hexagon and the thread, as the width across the flats would be less than the diameter of the screwed portion of the pin.

Fitting the Brackets

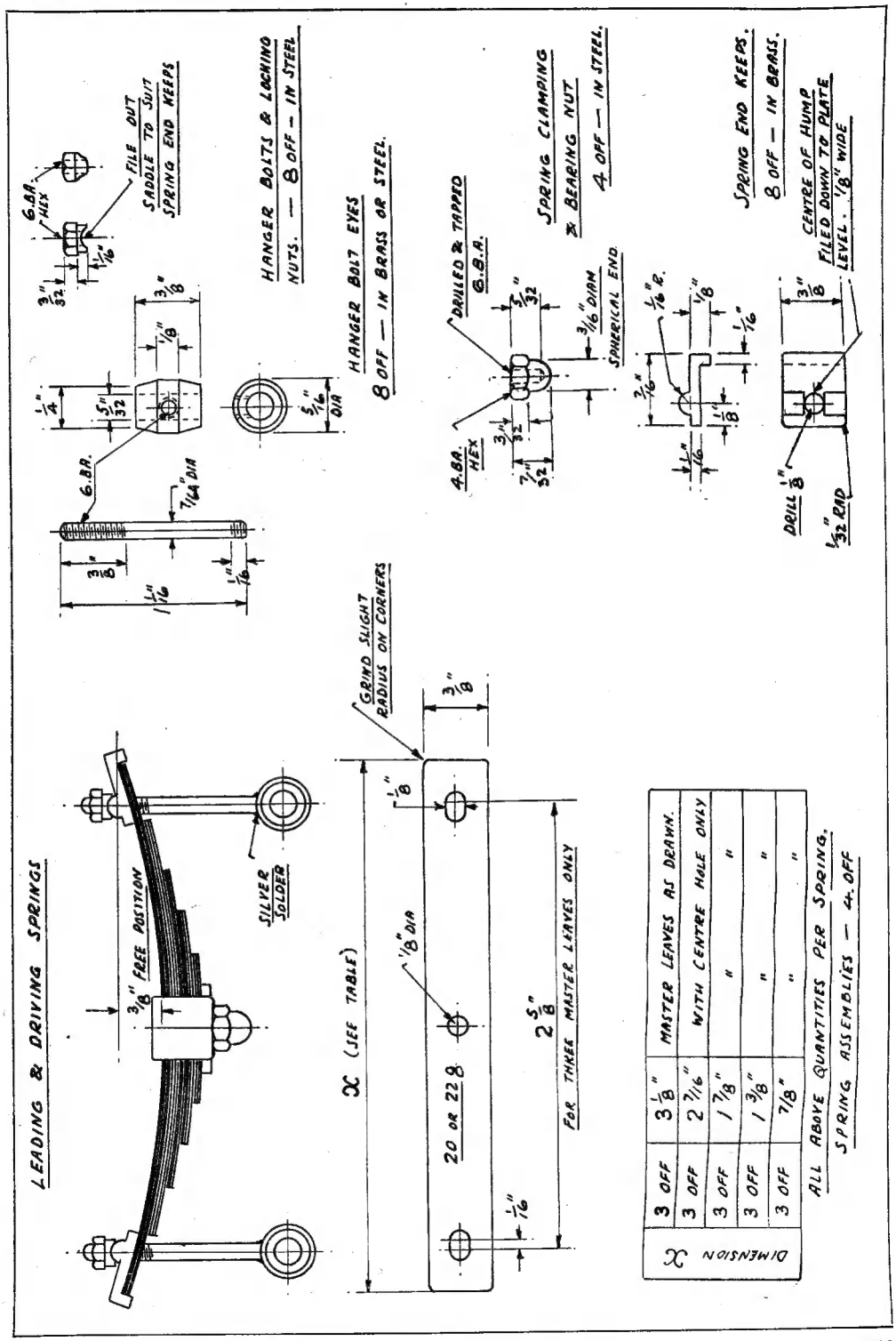
Exponents of the dismantleable (nice word, that) type of frames score a distinct victory here, as the rivet hole at the bottom of the bracket could never have been drilled in the frames of the locomotive satisfactorily, to be transferred to the finished brackets afterwards, or at least, not too conveniently; but these people can have the frames laid apart in almost a matter of minutes. The procedure is as follows :—

Screw a hinge-pin into each hanger bracket, when it will be noticed that a part of the pin projects on the other side. Press this into the hole drilled in the frame (see frames drawing) with the lower part of the bracket free to swing into any position. Bring each one close into the side of its respective horn-cheek, not worrying if it is not quite vertical, and clamp it in place. The hole in the bracket now forms a jig for drilling through the frames.

Rivet up with a snap-head on the bracket side, and a flush head in the frames. Folk with the undismantleable (even better) job need not worry. Place the bracket on the outside of the frame and by careful sighting to dodge the horn-cheek inside, clamp in position as before, and drill through; that particular bracket will match up when transferred to its final place inside the frames.

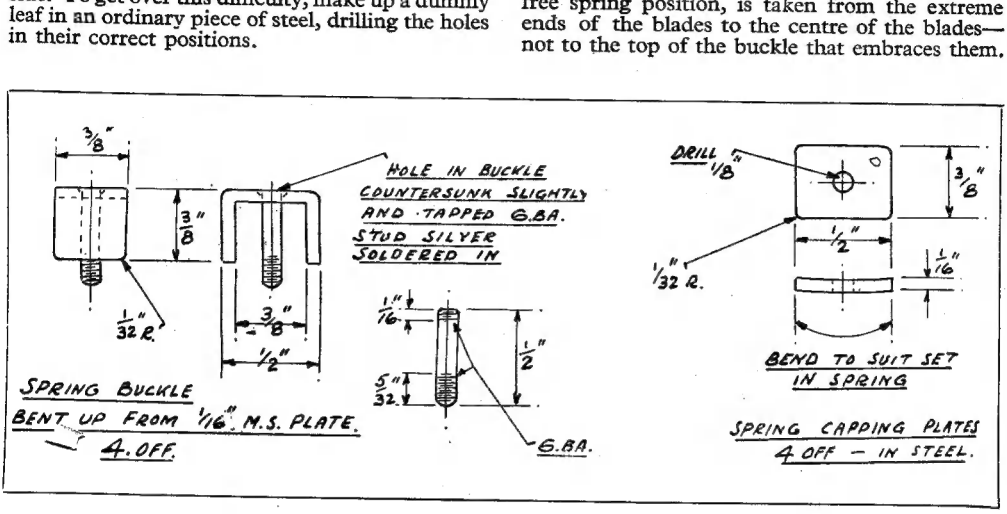
The next job is the making of the actual spring

*Continued from page 658, "M.E.," November 24, 1949.



DIMENSION X	MASTER LEAVES AS DRAWN.
3 OFF	3 1/8"
3 OFF	2 7/16" WITH CENTRE HOLE ONLY
3 OFF	1 7/8" " "
3 OFF	1 3/8" " "
3 OFF	7/8" " "

leaves, and about 10 ft. of old clock-spring will be required to complete the four spring assemblies. If, as previously mentioned, you intend making up a flat-faced punch and a piece of lead to punch the holes, you may wonder how best to ensure the punch going through the spring *where you want it to go*. It is very easy to position the punch on the end of a slippery piece of steel leaf, only to find that in the process of directing a blow on the punch, that it has slipped to one side. To get over this difficulty, make up a dummy leaf in an ordinary piece of steel, drilling the holes in their correct positions.



By clamping this to the spring leaves, the drilled holes will act as guides for the punch, and you should have no more trouble.

Correct Spring Setting Essential

When cutting off the spring leaves to the lengths shown on the table, allow a full $\frac{1}{8}$ in. extra length, and then do the necessary hole punching. After this has been done, grind up the blade ends on the ordinary bench grinder, bringing them to their final correct length. If in the process of doing this, the steel becomes a little blued locally, it will be all to the good and will do much to prevent cracks developing in the region of the punched hole, where there is bound to be some unrelieved stress. At the same time, grind the corners to a very slight radius to remove the viciously sharp points left from grinding.

The setting of the spring leaves is one of the most important things to watch. If you have secured a number of old clock-springs and have had the exquisite pleasure of unwinding them, you may or may not have discovered a way of getting them to stay unwound.

A very good method is to draw the spring backwards over a piece of hard wood or smooth metal, so that it bends over the edge of it. You will soon discover the angle required to cancel out much of its original set. Once this has reached the approximate curve, it will be in order to cut it up into pieces as directed. Final corrections may be carried out by drawing the blades through the fingers, still giving a bias to the angle at which each blade is drawn through.

This method is far superior to that of attempting to secure the right curve by direct local bends at frequent intervals in its length; this will most likely produce a long series of very small "flats" — a condition we are more than anxious to avoid and, incidentally, one that has a marked influence on the functioning of the completed spring.

Notice also that the dimension given for the free spring position, is taken from the extreme ends of the blades to the centre of the blades—not to the top of the buckle that embraces them.

The spring buckle is a very simple job, made from bent-up steel plate over a scrap of metal the correct thickness. To fit the spring to give a really neat appearance, measure the exact width of the spring steel being used, and make the forming bend block just slightly less. The completed buckles may then be filed out to make the leaves a good snug fit in them.

Make up the little studs, remembering to tap the holes in the buckle tops as well as giving a very slight countersink to the hole—just enough to provide a fillet of silver-solder that won't be filed away when the top of the buckle is cleaned off flat.

The closing or capping plate not only performs the function its name suggests, but by being bent to suit the curve of the spring when set, does much to retain the intended form of the spring unit.

The spring end keeps are by no means an ornamental finish to the spring, and these do the job of keeping the hanger bolts from sliding down the elongated punched holes in the spring blades, towards the centre of the spring.

The shape of these keeps suggests their being made in much the same way as the spring hangers, the same length of bar as specified for the hangers being applicable to these. Once more, the baby bench shaper would make short work of the job, and far more conveniently than by milling in the lathe, in this particular case.

You could substitute a much more easily made keep than that shown on the drawing, and builders of "Minor" might like to take note.

Instead of a machined strip, a plain brass strip $\frac{1}{16}$ in. thick and $\frac{3}{8}$ in. wide could be bent up to simulate the former version, but instead of the "hump" for seating, and, incidentally, locking the nut on top, a "Vee" cut across the face of the plate, and the nut modified to give a similar male "Vee" into which it could sit, would do the same job with very little loss of appearance, and no loss of efficiency.

Whichever type you decide to make, one point is important to both. See that the bent-over, or machined heel of the keep plate engages the end of the spring quite closely, otherwise it will have a disconcerting way of swivelling round out of place.

With the exception of the above alternative, everything has been pretty plain sailing, and the saddled-out nuts should need no explanation. Just in case there is any doubt (and it is amazing to read some of the queries that reach me in the course of a week) these nuts are turned with an extended portion below the hexagon part. They are then held in the vice, and the plain portion is filed right across with a small file, until it fits the hump on the keep plate. That's all there is to it.

The hanger-bolt eyes are nothing more than a kindergarten turning job, and when the side hole has been drilled and tapped, the hanger bolts may be screwed in and silver-soldered as shown. Pass a drill or reamer through the main hole to make sure it will go on the hinge-pin; quite a free fit is required here, and another job is done.

When making the spring clamping and bearing nut, with its domed head, remember that this sits inside the cupped screw fitting on the top of the axlebox. The fit here should be very free—even a bit sloppy, for it is important to allow the axlebox to slide and tilt sideways without twisting or pulling the spring with it.

If you wish to complete and assemble the springs on the frames, you might as well paint them and have done with it. The springs, after degreasing in petrol or turpentine, should be carefully painted with a dull black paint; Berlin black or "Roscoe" cylinder black are both suitable finishes. Paint the entire spring and buckle, including the keep plates. The eye of the hanger bolt should be black with the bolt portion left bright. The nuts are also left bright, including the domed nut under the spring.

Assembling the Springs

When first the spring leaves are assembled, have the domed nuts *quite tight*, and check up the free spring position as given on the drawing. Anything within 1/32 in. is quite in order, but on no account attempt to alter the spring setting by slackening the nut. These springs cease to work *effectively* if the spring blades are loose. If the tightened position gives a spring with too much or too little curve, then the assembly must be taken apart and each leaf corrected *individually*. It is no good thinking that the first half-dozen leaves corrected will pull the other leaves into shape, because if you do this, the value of the spring will be false, and it will be liable to become "lazy" long before the correctly-set spring.

Having got all four assemblies to a satisfactory setting, pass the hanger bolts through the spring ends, thread on the keep plates, and screw on the nuts. Remove the hinge-pins, sit the spring in its cup-head bolt, and by flexing the spring bodily, enter the eyes in the brackets and replace the hinge-pins.

When the engine is stood on its wheels, carrying only its own weight, there should be only the slightest movement of the axlebox in the horns, say 1/64 in., and by adjusting the top nuts you should be able to get this requirement in a moment or so.

I may appear to be stressing the whole question of springing to an unnecessarily fastidious degree, but later, when some real weight has to be carried, you will have the satisfaction of seeing a locomotive standing correctly trimmed on its wheels, with no distressing tilt forwards or backwards, or leaning dismally to one side or the other. Quite apart from this, an engine that does not slip excessively when starting with a heavily loaded train, owes a very great deal to the care and thought that has been put into its springing system. This little locomotive in particular, with its very short wheelbase, and considerable and heavy overhang at each end, calls for careful treatment, and I have no wish to see an engine that wobbles like a party jelly when touched, nor emulates an excited rocking chair—built to perform in more than one direction.

Now, have I forgotten anything? Perhaps an extra few words about the slotted ends of the spring leaves. The drawing shows the master leaves having the end holes slotted or extended inwards, obviously to allow the hanger bolts to swing without interference.

These slots cannot be filed out in hard steel, but may be punched out with the same round punch used for the other holes. You merely move the punch along a little way—rather less than half its diameter, and sitting on a fresh part of the lead block underneath. I usually make just two extra "nibbles" to achieve this, and have never had one go wrong yet.

Just occasionally, one meets a stubborn piece of spring steel that simply will not punch through without splitting out at the end of the blade, an indication that the temper is somewhat harder than usual. To counter this, use a small piece of well annealed copper plate, about $\frac{1}{8}$ in. thick, instead of the lead block.

Have this copper plate on a very good and solid backing, like an anvil, and I doubt if you will experience any more trouble.

As a final leaving-off point at this stage, I have discovered a mistake in one of the dimensions given for a pin length. This is the drawbar eye pin; it is shown as having a total length of $1\frac{5}{16}$ in. The correct length should be $\frac{13}{16}$ in. Come to think of it, $1\frac{5}{16}$ in. badly written can easily be mistaken for $\frac{13}{16}$ in., especially when viewed through tracing cloth, and in the early hours of the morning.

It is a good thing that we have no trade union looking after our affairs, otherwise they might be shocked to see the total number of hours enthusiasts like ourselves put in, in the course of a normal week.

(*To be continued*)